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TEXAS AGRICULTURAL EXPERIMENT STATIONS

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# Strawberries Under Irrigation In South Texas

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# STRAWBERRIES UNDER IRRIGATION IN SOUTH TEXAS.

By E. E. Binford, B. S., Superintendent, Beeville Sub-Station.

## INTRODUCTORY.

For some years the strawberry crop has held more or less prominence in parts of Texas, and, of late, attention has been given to the production of the crop under irrigation in the Gulf Coast country of South Texas. Only in the last two or three years has any attention been directed to the crop in the lower Rio Grande region, and last year witnessed a considerable production. In the counties farther north, namely, Bee, Goliad, Victoria, Jackson and some others, strawberries have been raised, partly under irrigation and partly by dry farming methods. Some growers have been eminently successful while others have practically made failures. The failures have been due quite largely to the lack of knowledge concerning methods of handling the strawberries, particularly in protecting the plants from the hot sun during the summer months. It is with a view of giving certain information that may be of benefit that the author has undertaken some investigations as to various varieties and methods in connection with the production of strawberries in this region.

In the lower Rio Grande district, not more than enough strawberries have been produced to supply the local demands up to the present time. The marked success of some half dozen growers in the last year has caused a considerable number of farmers to undertake the production of strawberries. Attention should be called to the fact that the comparatively high prices that have been received for strawberries in the South Texas country have been due to the fact that the local demand was no more than supplied. With the anticipated increase in acreage in the lower Rio Grande Valley it is probable that attempts will be made to ship the berries to the larger market centers and some doubt is entertained as to the advisability of doing this on account of the long distance from the market and the perishable character of the product. To see the reasonableness of such a doubt, it is only necessary to consider the vicissitudes that have accompanied the production of other truck crops in the region. The data contained in this publication has been secured by experiments on the State Experiment Sub-Station at Beeville, Texas, and by direct investigation among the growers of strawberries in the region.

## SOILS.

Generally speaking, medium textured soils are satisfactory for strawberry production. Contrary to demands of most plants, strawberries do not require so much lime; in fact, strawberries will do well in soils that are slightly acid. A considerable amount of organic matter, such as is found in muck soils, is to be recommended. Alluvial soils in this region, except the heaviest clays, are doubtless adapted to strawberry produc-

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tion. Among the soils of Southern Texas on which strawberries are likely to succeed, with irrigation, are the following:

Houston loam, which consists of 8 to 15 inches of black sandy loam to loam; Goliad loam and Goliad sandy loam, which consist of 8 to 15 inches of black sand loam or loam; the Miller silt loam, which consists generally of 14 inches of reddish silt loam, found along some streams; the Beeville fine sandy loam; the Victoria loam; Victoria fine sandy loam; the Edna loam and Edna sandy loam; the Trinity clay, which consists of several inches of black loam or clay loam on the surface and is alluvial in origin; the Brennan fine sandy loam, which consists of several inches of gray to brown sandy loam or loam. These soils have been classified and mapped by the United States Bureau of Soils and their location can be determined by reference to the publications secured from this source.

The soils of the lower Rio Grande Valley that are adapted to the growth of strawberries are the Laredo silt loam, which is not very extensive; the Laredo silty clay loam, which is known as the "resaca" soil or "ebony" soil of the region; and Laredo clay.

## PREPARATION.

The land to be devoted to strawberries should be prepared in a very thorough manner in order to get rid of as many weeds and to get the soil into as good a condition, as possible. It will be found advantageous, oftentimes, to apply barnyard manure and to plow this into the soil and also to plow under a crop of cowpeas sufficiently in advance of transplanting to allow the organic matter to rot. The breaking for strawberries should be done in August or September, if the transplanting is to be done in the early fall. Some of the successful growers maintain that the ground should be broken, if possible, to a depth of 6 or 8 inches. The breaking should be followed with a disc and smoothing harrow until the soil is thoroughly pulverized and in good condition.

Where any crop is to be produced under irrigation the necessity for leveling the ground is apparent, and this is especially true where strawberries are produced, on account of the fact that if the water comes in contact with the vines during the hot season of the year, the vines will scald and die. Water should never be allowed to come in contact with the berries as that will make them soft. To overcome such conditions, the ground must be leveled and a grade of not more than two or three inches to the hundred feet is sufficient. The furrow system of irrigation should be used and the best method yet tried is that of making ridges and furrows before the plants are set out. One grower who has been successful near Brownsville, made his ridges about one foot high and about one and one-half feet apart. This, however, is too close for practical operation. Beds should be thrown up two feet wide, from eight inches to a foot above the bottom of the furrow and the distance between these beds should be about three feet. Then, one row of plants may be set out on each side of the bed, making two rows every five feet.

Where single row ridges are thrown up it will be found advantageous,

particularly during the ripening period of the berries, to arrange the irrigation system that the water can be applied in furrows so that every other furrow may remain dry, for the convenience of the pickers. Where the double row system is used the pickers will necessarily be compelled to walk on the tops of the beds between the rows when it is

FIGURE 1.*
A—Plant ready for transportation. B—Plant before trimming.

too wet to get into the furrows. This system of planting will permit of cultivation with a horse or mule. If the rows are planted close together, it will not be advisable to put in an animal to pull the cultivator. Strawberries require a large amount of water and consequently more

*Courtesy of Department of Horticulture, Purdue University Experiment Station.

thorough cultivation must be provided because the constant application of water by irrigation will make the soil compact, and crusting will frequently occur. The rows therefore should be sufficiently long to make it practicable to plow with a horse. Where the plants are set on the double-row beds, the hand cultivator should be used on the beds between these rows.

## TRANSPLANTING.

The present practice in the Rio Grande region is to set out the plants in September or October, the crop being taken off from January to May following. If it is not desired to secure a heavy crop of strawberries the first year, later transplanting may be done with profit. The plants should be trimmed, the bruised roots cut off and the dead or old leaves removed before they are set out. Figure No. 1 shows condition of the plants when ready to be set out.

Figure No. 2 shows the various positions in which plants are sometimes placed; the character, depth and position of roots being shown.

On account of the fact that up to the present time, very few people in the lower Rio Grande region have learned how to carry the plants

FIGURE 2.*

Plant set properly. Set too shallow. Set too deep. Roots carelessly bunched.

over the summer, the tendency has been to set the plants very thickly during the early fall with the idea of making the total income during the following winter and spring months only. The methods necessary for carrying the plants over the summer have now been determined and since the crop is much greater during the second and third years than it is the first, these methods should be understood by every grower. Where the plants are set on ridges one and one-half feet apart and eighteen inches apart in the row, 19,362 plants to the acre will be required. Where the ridges are three feet apart and eighteen inches between plants in the rows, 9,680 plants will be required to the acre. Where the double-row bed system is used, and distance between beds

*Courtesy of Idaho Agricultural Experiment Station.

is three feet and the rows on the beds are two feet apart, 11,616 plants to the acre will be required. Where the plants are carried over the summer and a second year's crop is produced, this will be found to be amply sufficient as the plants will spread out considerably during the second year.

---

The following conclusions have been arrived at after experiments were conducted at the Beeville Experiment Sub-station:

"Plants should be set in three-foot rows, from 18 inches to 2 feet apart. This will give from 9,680 to 7,260 plants per acre. It is not advisable to set plants closer than this. Runners should be kept closely cut. Too close setting will give a maximum amount of small and inferior fruit.

VARIETIES.

There are a large number of varieties of strawberries, but only a comparatively small number of them are known to be adapted to the South Texas region. Among those varieties that have been successfully grown in the lower Rio Grande region, are the Saint Louis, Klondike, Lady Thompson and Buster.

At Beeville, 41 varieties have been tested and the following are among the best that have been grown there under irrigation:

BRANDYWINE: This is a late ripening variety and is vigorous and fruitful. The flowers are perfect. The fruit is large, firm and of good color and flavor. The berry is conical to angular; in color it is red and the flesh is mildly acid. The plant bears a medium number of runners. The fruit is of good shipping quality. It is one of the best varieties tested at the Beeville Experiment Sub-Station.

SAINT LOUIS: This is an early ripening variety, and is fairly vigorous and productive. The flowers are perfect. The fruit is large, soft and light in color. It is one of the best varieties for home use.

KLONDIKE: This is an early ripening variety which is fairly vigorous though it does not produce a large number of runners. The flowers are perfect. It fruits abundantly and the berries are large, smooth and uniform and of excellent flavor and color. The flesh of the berry is red, acid and firm. It is one of the best varieties tested at the Beeville Experiment Sub-Station.

BUSTER: This is a medium early fruiting variety and of good color and size. The variety is resistant to drouth and produces plentiful runners.

LADY THOMPSON: This is an early ripening variety, which is vigorous and productive. It has perfect flowers. The fruit is of good quality, resembling the Klondike except being a little more oblong in shape. The flesh is pink, sub-acid and medium firm. Its shipping quality is fair. It produces runners in medium number.

MARSHALL: This is a medium ripening variety, which is vigorous and fairly productive. The flower is perfect. The fruit is firm and of good color and flavor. It is among the best of varieties tested at the Beeville Experiment Sub-Station.

BEN DAVIS: This is an early ripening variety, which is vigorous and productive. It has perfect flowers. The fruit is large and of good

color. It is one of the best varieties tested at the Beeville Experiment Sub-Station.

MICHAEL'S EARLY: This is an early variety which is vigorous and moderately productive. It has perfect flowers, fruit is medium firm and of good color and size. It is the earliest variety tested, as well as one of the best.

## SEX OF PLANTS.

"The sexual status of the variety should be known, since some kinds of strawberries bear imperfect, pistillate or female flowers which will not set fruit unless they receive pollen from perfect male or staminate flowers borne on other varieties. These last will set fruit from their own pollen.

At least one row of a perfect flowered variety should be set beside every three rows of an imperfect flowered kind. Imperfect fertilization is often indicated when nubbins, berries with hard, greenish, undeveloped tips, are found plentiful on any variety.*

All of the varieties that are described above are perfect flowering plants, and, consequently, an intermixing of varieties is unnecessary when any of these are used.

## SPRAYING.

"The principal strawberry diseases are mildew and leaf spot. The mildew is usually most serious during the warm, muggy weather of early summer toward the close of the bearing season. Here in the warm climate of Texas probably the best treatment for this trouble is sprinkling the plants with powdered sulphur so that the heat of the sun will slowly vaporize the same, killing the mildew as in the case with the rose.

The other disease, leaf spot, or blight, appears as reddish or red edged spots scattered over the leaf or running together in serious cases, usually most abundant on the older leaves. When this disease appears in the late summer upon the leaves of the preceding season one need have but little anxiety over the probable damage. If, however, the disease appears early in the season, attacking the fresh foliage, the plant should be promptly sprayed with Bordeaux mixture of 4-4-40 formula.† Two or three sprayings with this fungicide at intervals of two or three weeks, as the progress or the changing of the disease indicates, are usually sufficient. Where the disease is of annual occurrence and serious it is often of much value to cut the tops as soon as the picking season is over, gathering these and removing them from the patch to be burned, allowing an entirely fresh growth to develop. And spraying of this new growth is doubly effective in the absence of the diseased material of the preceding season, which has already been removed."‡

*Bulletin 336, Agricultural Experiment Station, Geneva, N. Y.

†4-4-40, Bordeaux Mixture, consists of 4 pounds copper sulphate, 4 pounds slaked lime, and 40 gallons of water.

‡Dr. F. H. Blodgett, Plant Pathologist, Texas Experiment Station.

### RULES FOR PICKING AND PACKING.

In no case should berries be picked when there is moisture on the vines.

Berries should not be picked until they are entirely pink or three-fourths red.

In cold weather berries may be picked when they are riper than when the weather is warm.

When berries are to be packed, the pickers should not be allowed to hold several berries in their hands at the same time. Berries for shipment should be picked leaving half-inch stems. Berries for shipment should not be touched with the hands.

The berries in boxes should not be allowed to stand in the sun. There should be no culls in the box; only full sized berries should be used for shipment.

After the box is half full, the berries should be placed stems down so that the top layer will be level. Boxes should be filled solid, leaving the least possible amount of vacant space, especially at the corners or they will be short in weight and they will settle, and therefore bring less money.

The top layer of the box should be three-eighths of an inch above the top of the box and the top row should be no better than the bottom. Packers must be required to sort out all green, over-ripe, misshapen or undersized berries.

Clean crates and clean boxes should always be used.

The foregoing directions are practically those that are given out by the Idaho Experiment Station in Bulletin No. 70 and are followed by growers in that State.

### IRRIGATION.

Except on some low, sub-irrigated soils, strawberries cannot be profitably produced without irrigation in this region. As previously stated, the water should be run in the furrows, but should never be allowed to touch the plants. The moisture should reach the roots by capillarity. Some successful growers advocate that the irrigation should be done at night, especially during the hot summer months. The amount of irrigation will depend upon the amount of rainfall and the character of the soil. The more thorough the cultivation, the less will be the amount of water required. Excessive irrigation during the time when the strawberries are in bearing should be avoided or there will be danger that the fruit will become soft. On some soils, growers state that it will be necessary to irrigate as often as once every week or ten days during the summer months on account of the great heat and rapid evaporation.

### PICKING SEASON.

The ripening season in the vicinity of the Beeville Experiment Sub-Station begins about March 15th. This, however, depends upon the season. In the season of 1911, ripening began about May 1st. In the lower Rio Grande region, ripening of the earliest varieties begins in

December and the picking season continues oftentimes until the latter part of May.

"In the height of the season the berries will have to be picked every day, but at the beginning and end of the season every other day, or once or twice a week will be sufficient, though at the end of the season the berries will get so soft that daily picking may be necessary."*

### SUMMER TREATMENT.

On account of the fact that the second and third years are the best for the production of strawberries it is essential that every possible care be taken to insure the life of the plant during the summer months. Various methods have been tried, but only two have thus far been found that have proved anything like successful. At the Beeville Experiment Sub-Station, nine separate tests were conducted with mulching, using cotton seed hulls. The hulls were applied in the spring following the picking and the plants were practically covered. Irrigation was provided eight times during the summer. In October the mulch was removed and in none of the nine tests were there less than 81 per cent of healthy plants. The average of the nine tests showed that 84 per cent of the living plants in the spring were healthy and vigorous when the mulch was removed in October.

Another, entirely different system of protection was provided by a grower in the lower Rio Grande region. In this case, popcorn was planted in the bottom of the furrows between the rows of strawberries. The strawberries were irrigated at frequent intervals during the summer. As the popcorn grew, the lower leaves were stripped off so that air circulation was provided about the plants. It is impossible to say just what percentage of the plants on the acre was lost. The following year this grower did not plant popcorn in the furrows, but allowed the weeds to grow. This was found to be much less satisfactory than the use of popcorn, as a considerable number of plants were found to be dead before the summer was over, particularly in the spaces where the weeds were not tall or abundant.

Other methods have been tried for preserving the plants during the summer, among which are the use of straw mulch, use of cane, and the use of cotton, planted between the rows. None of these have proved satisfactory. Suggested methods are the use of shredded cane from the sugar mill as a mulch, and the growing of castor beans between the rows. Present indications point to the use of popcorn as the most satisfactory method of shading the plants during the summer in the lower Rio Grande region, and this will probably be satisfactory in the greater part of the irrigated district. Cotton seed hulls are expensive when purchased in an amount sufficient to mulch any considerable area of strawberries.

### COST OF PRODUCTION.

The determination of the amount of work required and the amount of cash outlay in the production of strawberries are difficult on account

*Rio Grande Horticultural Society.

of the scarcity of definite records where strawberries have been produced, but several growers were interviewed and the estimation of the amount of labor required and the cash expenses were determined so far as possible for one acre.

*The average of these records is approximately as follows:

| | Man Days. | Horse Days. |
|---|---|---|
| For breaking, discing, harrowing and leveling | 1½ | 5 1/6 |
| For ridging or preparing beds | 2 | 4 |
| For working on borders and ditches | 2 | |
| For transplanting 10,000 plants | 8 | |
| For twelve irrigations | 6 | |
| For fifteen cultivations | 15 | 15 |
| For hand work with the hoe | 12 | |
| For spraying | 6 | |
| For weed pulling by hand | 10 | |
| For planting popcorn for summer shade | 1 | 1 |
| Total | 56½ | 25 1/6 |

Of the cash expenses the following is an average summary of the data available:

| | |
|---|---|
| Picking 2,000 quarts (estimated yield per acre at 3c) | $ 60.00 |
| 10,000 plants per acre at $3.50 per thousand | 35.00 |
| Boxes for 2,000 quarts | 12.00 |
| Cost of irrigation water | 10.00 |
| Interest on land valued at $150 per acre at 6 per cent | 9.00 |
| Value of man labor, 56½ days at 75c | 42.37 |
| Value of mule or horse labor, 25 1/6 days, at $1 for each horse | 25.17 |
| Total expenses for first year per acre | $193.54 |

It must be borne in mind that these figures are not absolute. Various growers will adopt methods of their own which will require greater or less labor in the various operations. It should be noted that no charge is made for overseeing the operations which will be absolutely necessary when the character of the labor of South Texas is taken into consideration. If the land owner undertakes the production of strawberries himself directly, his labor per day is of greater value than seventy-five cents, which is the average wage for Mexican labor. When growers generally have learned the methods of carrying the plants over the hot summer the necessity for replanting every year will be eliminated and, consequently, a very material lessening of expense will be noted the second year. The original cost of plants and the cost of transplanting, of course, will be done away with as well as the original preparation of the ground so that the cost after the first year will be decreased to approximately $100 per acre.

*Courtesy of Office of Farm Management, United States Department of Agriculture.

## CONCLUSIONS.

Strawberry production under irrigation in some portions of South Texas is in its infancy, although some growers have been eminently successful in supplying the local market. It must be borne in mind that when the local demand is supplied, the same difficulties of marketing the product will be encountered as in disposing of other truck crops.

Soils that are adapted to the production of strawberries are generally of a sandy loam or loam character, although some of the heavier soils, particularly those of alluvial origin, are well adapted.

The most thorough preparation of the soil for strawberries is essential. Barnyard manure plowed into the soil and allowed to rot will generally prove advantageous. The plowing under of a crop of cowpeas two or three months previous to the setting of strawberries will add organic matter that will generally prove beneficial. Strawberries should be planted on ridges or beds two feet wide with three feet between the beds. This will provide two rows to every five feet. Thorough cultivation should be given as soon as possible after each irrigation. Rows should be so long that it will be practicable to plow with horse or mule. Cultivating between the rows on the beds may be done with a hand cultivator.

Plants should be set not closer than eighteen inches apart in the row. Where the transplanting is on this basis, with two rows to five feet, 11,616 plants will be required to the acre. After the first year, the plants will be found to be amply close together by this practice. Too close planting will have a tendency to give a maximum of small and inferior fruit.

Only four or five varieties of strawberries have thus far been grown successfully in the extreme South; the Saint Louis, Klondike, Lady Thompson and Buster are satisfactory. Other varieties that have tested well at the Beeville Sub-station are the Brandywine, Marshall, Ben Davis and Michael's Early.

When strawberries are put out it is essential that the sexual status of the plants be known. Imperfect pistillate or female flowers will not set fruit unless they are fertilized from a perfect male or staminate flower borne on another variety. The perfect flowering plants, however, are self-pollinating. All of the varieties mentioned in this publication are perfect flowering plants.

Some plants in South Texas have been attacked by "sphaerella fragariae," which is a fungus disease affecting the leaves. A spray of 4-4-40, Bordeaux mixture, should be used for the control of this disease.

Where strawberries are to be handled on a large scale, in order to be shipped, great care must be exercised both in picking and packing, in order that every possible advantage may be made use of in getting the fruit on the market.

The amount of irrigation required for strawberries will necessarily be determined by the grower. Care must be exercised that excessive irrigation is not provided during ripening period or the berries may be too soft for commercial use. Frequent irrigations will be required in the summer both on account of evaporation and the growth of popcorn shade.

Picking season in the lower Rio Grande region is from December to the latter part of May, depending somewhat upon the season. Farther north, in the vicinity of Beeville, the picking season is from the middle of March to the latter part of May, although this will depend quite largely upon the season. Berries must be picked every day when the season is at its height.

It is essential that methods be followed which will insure the life of the strawberry plants to the second and third years. The use of a surface mulch of cotton seed hulls has proved satisfactory in the region about Beeville. In the lower Rio Grande region a shade provided by popcorn between the rows has proved satisfactory.

The cost of production of strawberries will be approximately $200.00 per acre for the first year. If the plants are carried over the summer successfully, the second year's cost will be reduced by about one-half.

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TEXAS AGRICULTURAL EXPERIMENT STATIONS

Circular No. 2, New Series. January, 1914.

# *Anchoring Houses in Overflow Districts*

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COLLEGE STATION, BRAZOS COUNTY, TEXAS

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1914

# ANCHORING HOUSES IN OVERFLOW DISTRICTS.

BY B. YOUNGBLOOD, DIRECTOR.

A considerable loss of houses occurred during the recent floods on the Brazos and Colorado rivers and their tributaries, which might have been avoided had the houses been securely anchored to the earth.

For the convenience of those wishing to secure their houses so that they will withstand the heaviest floods, the writer has had Professor A. Mitchell of the School of Engineering, A. and M. College of Texas, prepare plans for two kinds of foundations or piers, to be used in anchoring houses in the river bottoms. The first design, as shown in Figure 1, calls for three logs, an iron rod, two washers, two nuts, and some tar for painting the iron. It shows the pier to be a log averaging 10 inches in diameter, and the other two logs, or "dead men," 12 inches in diameter; the rod to be 11 feet and 8 inches long and 1¼ inches in diameter, assuming that an elevation of six feet is necessary in order to keep the house above the water in times of highest overflow. These materials obviously are of sufficient dimensions for most any building likely to be built in the bottoms. For the smaller tenant houses, provided they are not built in a location where the current is likely to be very strong in times of overflow, smaller rods and shorter "dead men" might be used with safety. The only reason, however, for reducing the size is the matter of saving a few dollars per building in the cost of iron. The elevation of the house is purely a matter of judgment on the part of the farmer. He can determine for himself how high each building should be elevated above the ground in order that it may remain out of water when the floods are highest. The marks on trees and buildings made by the recent overflow are a very good basis for an estimate of the proper elevation.

The iron should all be cleaned, and painted with hot tar to prevent rusting. A 2x6 stringer, shown in the figures, on top of the floor joists, is provided to overcome the buoyant force of the water and to hold the house firmly in position on the piers.

## SETTING THE LOG FOUNDATION.

In setting the log foundation, dig a trench five feet deep, eight feet long, and wide enough for a man to work in. Through the log bore a hole 1⅜ inches in diameter, three and one-half feet from the end of the eight-foot log. Put the iron rod through this hole, put on the washer, and screw up the nut on the rod. Drop the log into the trench with the rod standing vertically. At right angles to this trench and across the middle, dig another trench six or eight feet long, to the level of the top of the log first placed. Into this trench drop the other log, close to the rod, as shown in the plan of Figure 1.

On top of the second log set the upright post on the horizontal log, at the point of intersection, hewing the bearing surface slightly to give

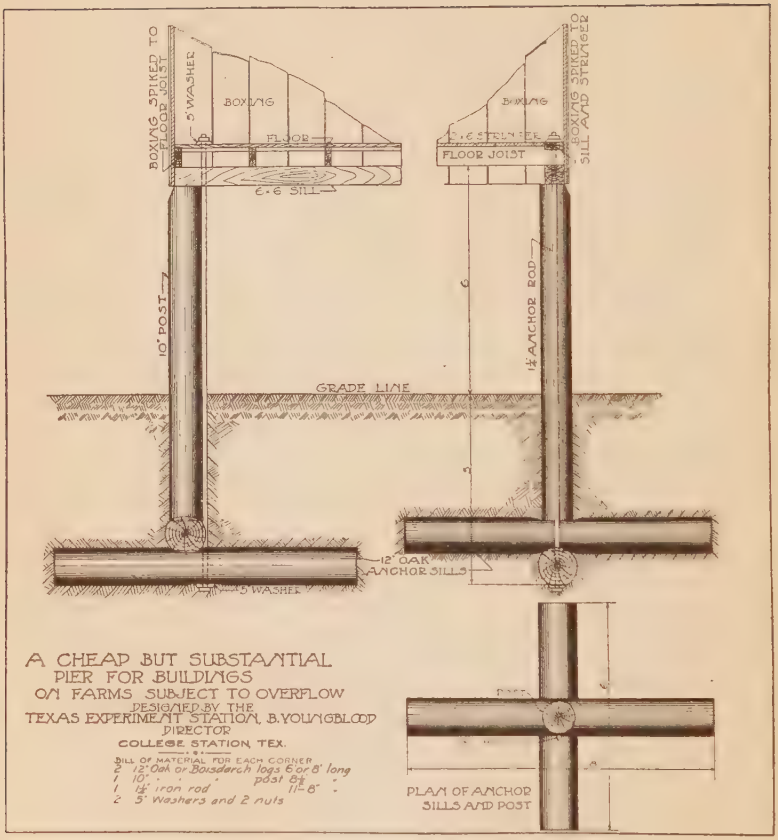
BOXING SPIKED TO FLOOR JOIST
5" WASHER
BOXING
FLOOR
2-6 SILL
10' POST
GRADE LINE
BOXING
2-6 STRINGER
FLOOR JOIST
BOXING SPIKED TO SILL AND STRINGER
1¼" ANCHOR ROD
12" OAK ANCHOR SILLS
5" WASHER
A CHEAP BUT SUBSTANTIAL PIER FOR BUILDINGS ON FARMS SUBJECT TO OVERFLOW
DESIGNED BY THE TEXAS EXPERIMENT STATION, B. YOUNGBLOOD DIRECTOR
COLLEGE STATION, TEX.
BILL OF MATERIAL FOR EACH CORNER
2 12" Oak or Boisdarch logs 6' or 8' long
1 10" " " post 6' " "
1 1¼" iron rod 11'-8"
2 5" Washers and 2 nuts
PLAN OF ANCHOR SILLS AND POST

FIGURE 1. Showing detail of log anchor.

a smooth footing for the post. Fill up the trenches with the same soil as originally removed, and tamp carefully as filled.

Referring again to Figure 1, please note:

1. That the rod is anchored to the lower log.
2. That the upper log lies across the lower.
3. That it is not necessary to tie the logs together, as the soil will hold them in place.
4. That the post sets on the *upper* log immediately above its intersection with the lower.
5. That the logs must be surfaced at the bearing points.
6. That the rod passes through a solid sill (6x6 or 8x8, depending upon the size of the house), up between the floor joists, which should not be lighter than 2x6, and through a stiff stringer, not lighter than 2x6, which is notched into the floor joists.
7. That the rod is fastened by a nut resting on a washer not smaller than five inches in diameter.

---

## STRENGTH OF RODS.

The strength of the various sized rods recommended for use in the log foundations will be found in the following:

½-inch rod will hold an upward pull of..... 4,000 pounds
¾-inch rod will hold an upward pull of..... 8,800 pounds
1-inch rod will hold an upward pull of.....15,800 pounds
1¼-inch rod will hold an upward pull of.....24,600 pounds
1½-inch rod will hold an upward pull of.....35,400 pounds

These figures would indicate that even a one-half-inch rod would be sufficiently strong to hold the average river valley tenant house very securely, and, of course, is cheaper than the larger rod.

## COST OF IRON.

I am advised that these rods may be purchased of hardware dealers for three and one-half cents per pound, and the nuts and washers for eight cents per pound.

The following figures will give the weight of the rods of various sizes, per foot, from which one can easily compute the cost of a sufficient number of rods to anchor a given house:

½-inch rod weighs .67 pounds per foot.
¾-inch rod weighs 1.5 pounds per foot.
1-inch rod weighs 2.67 pounds per foot.
1¼-inch rod weighs 4.17 pounds per foot.

½-inch nuts weigh 14 nuts to the pound.
¾-inch nuts weigh 4¾ nuts to the pound.
1-inch nuts weigh 2¼ nuts to the pound.
1¼-inch nuts weigh 1¼ nuts to the pound.

Four rods 11 feet and 8 inches long, eight washers, eight nuts, and two 2x6s to go across the ends of the floor joists are all the materials that would have to be bought in order to anchor a rectangular house according to the plans suggested.

For convenience, we will figure that each nut and washer for the rods will cost five cents each, or a total of eighty cents per rod, for washers and nuts.

Using the preceding figures, the cost of hardware for anchoring one house will be as follows:

Using ½-inch rod:

| | |
|---|---|
| 4 rods 11 ft. 8 in. long=46.66 ft.=31.26 pounds at 3.5c per pound | $ 1.10 |
| 8 washers at 5c each | .40 |
| 8 nuts at 5c each | .40 |
| | $ 1.90 |

Using ⅝-inch rod:

| | |
|---|---|
| 4 rods 11 ft. 8 in. long=46.66 ft.=70 pounds at 3.5c per pound. | $ 2.45 |
| 8 washers at 5c each | .40 |
| 8 nuts at 5c each | .40 |
| | $ 3.25 |

Using 1-inch rod:

| | |
|---|---|
| 4 rods 11 ft. 8 in. long=46.66 ft.=125 pounds at 3.5c per pound. | $4.35 |
| 8 washers at 5c each | .40 |
| 8 nuts at 5c each | .40 |
| | $ 5.15 |

Using 1¼-inch rod:

| | |
|---|---|
| 4 rods 11 ft. 8 in. long=46.66 ft.=194.5 pounds at 3.5c per pound | $ 6.81 |
| 8 washers at 5c each | .40 |
| 8 nuts at 5c each | .40 |
| | $ 7.61 |

The cost of digging the trenches for the "dead men" and of getting out the logs are not included, but certainly the total expense, everything counted, is insignificant when considered as an assurance that the house will not be washed away.

Figure 2 shows plan for reinforced concrete pier, which is described as follows:

This figure represents two reinforced concrete piers, one for a corner and one intermediate pier. The specifications given are for 1:3:5 concrete. The footings may be reinforced with rods or old railroad rails, as shown in the sketch. The reinforcing should be placed near the

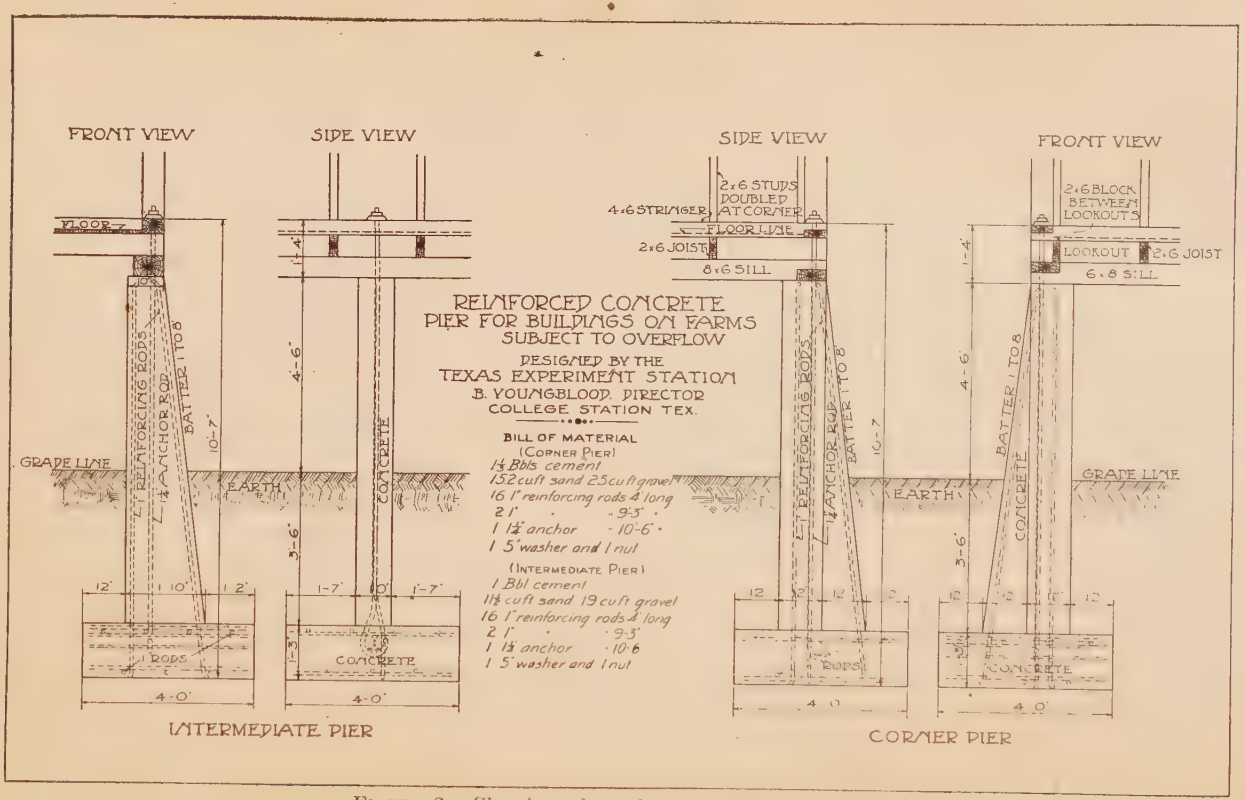


FIGURE 2. Showing plan of concrete pier, in detail.

upper surface of the footings, since that surface is in tension due to the upward and lateral force of the water in times of flood. The reinforcing rods and anchor rods should be bent at the ends, as shown. The stringer shown on top of floor joists should be stiff, as it is depended upon to hold the floor system down and overcome the buoyant force of the water. It is estimated that a force of ten tons would be required to lift one of these piers out of the ground, neglecting the pressure of the atmosphere, which, of course, would materially increase the force required.

---

Plantation owners are urged to anchor their houses, not only as a protection to the houses, but also to the lives of the people on the farms. The purpose in elevating the houses is twofold: First, to keep them above the water; and, second, to improve health conditions.

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TEXAS AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR NO. 3, NEW SERIES DECEMBER, 1913

DIVISION OF HORTICULTURE

# TRUCK FARMING

POSTOFFICE:
College Station, Brazos County, Texas

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# TRUCK FARMING.

By H. Ness, Horticulturist.

## INTRODUCTION.

The object of this bulletin is to furnish answers to the numerous inquiries in regard to the cultivation of truck crops coming to the Horticultural Division of the Texas Agricultural Experiment Station. Many of those making these inquiries are late immigrants from the other States, who have secured small farms in Texas for the purpose of going into truck farming; others are cotton and corn farmers, who are seeking to diversify their present one-sided and perhaps unprofitable system. It is not difficult to perceive that these people, in many instances, expect to produce their truck crops on lands already impoverished and worn; and that they expect to restore the fertility of the soil by commercial fertilizers especially compounded for each particular crop. Hence, the queston: "What ingredients and amounts of commercial fertilizers are best for each particular crop?" Many correspondents offer to send a sample of soil so that the Experiment Station may determine what class of crops are adapted to it, or what special fertilizers to prescribe for a given crop. The case is very similar to that of a person, whose energies are impaired by overwork and from living on poor and insufficient food, demanding a special tonic from the physician to restore his strength. The physician will say that no tonic will be of lasting good, and will prescribe plenty of wholesome food and reasonable rest, before more strenuous work is permitted.

Since the ideas concerning the maintenance and restoration of the fertility of the soil seem to be at variance with the actual facts, it is not inappropriate to preface this bulletin with a short treatise upon the improvement and the conservation of the soil.

## THE SOIL.

The first requisite to a productive soil is an abundance of available plant food; the second is, that the soil be sufficiently porous to allow a fair amount of aeration and subdrainage, and at the same time have the ability to retain moisture during drouths.

The ideal soil for truck crops, then, may be described as a loam of moderate compactness, good depth, underlaid by a clay that is sufficiently porous to be spaded with moderate ease. A sandy soil too loose and airy, or a clayey soil too stiff and compact, can readily be changed into the proper texture by the application of either stable manure or green manures. Of these, the green manure from cowpeas, plowed under when in full bloom, has decidedly the most beneficial effect. The decaying materials from such a crop renders the soil mellow, easily tilled, and especially retentive of moisture; nor is that "firing" of the crop in evidence so often noticed during drouths after applications of unde-

composed stable manure. Land subject to washing, no matter what texture, is more readily cured of this fault by crops of cowpeas given to it than by any other applications.

Besides this physical amelioration, the green manure from cowpeas gives the land nitrogenous fertilizer—much cheaper and much more lasting than the same amount of plant food applied to the soil from any commercial source.

It is evident, from the comparatively small use that is made of cowpeas as a fertilizer, and the ever increasing use of the costly commercial forms of nitrogen (which, at best, can only stimulate a single crop), that our farmers have failed to realize the great importance of cowpeas as a soil renovator and creator of fertility.

The Bureau of Soils of the National Department of Agriculture has, along with its soil surveys, carried on a series of experiments, embracing the same soils as the surveys, to determine the fertility of the soils as affected by manures. The mineral fertilizers used in these experiments consisted of high grade nitrates, phosphates, and sulphate of potash, applied at the rate of 200 pounds per acre and lime at the rate of one ton per acre. These fertilizers were used both singly and in combination, but always at the same rate. The organic fertilizers consisted of well composted stable manure, at the rate of ten tons per acre, and green cowpea vines at the rate of five tons per acre. This latter was always used in connection with lime. One hundred and eighty-six different types of soils, representing localities from all over the country, were thus tested. Each type gave rise to five experiments, exclusive of checks. In summing up, the author, Frank D. Gardner, makes the following statement on page 37, Bulletin No. 48, Bureau of Soils: "An Examination of Table VIII shows further the efficiency of manures and cowpea vines with lime as compared with a complete fertilizer (mineral) with and without lime. In the majority of instances the manures or cowpea vines with lime, or both, have proved superior to the mineral fertilizers. A careful analysis of the results shows that the manure and cowpea vines with lime nearly tie for first rank, while the complete fertilizer with lime ranks third, and without lime, fourth, or last. The relative number of times that each treatment ranks first on the basis of 100 for the whole is: Manure, 39; cowpeas with lime, 39; complete fertilizer (mineral) with lime, 16; and complete fertilizer alone, 6." It is noteworthy that in these experiments the amount of green cowpea vines used was only half as much by weight as that of the stable manure.

Another excellent virtue of the cowpea vines is the convenient season at which the crop can be grown; namely, after the removal of a spring crop, such as Irish potatoes, cabbages, onions, or any other truck crop; or even after a crop of winter grains. This puts the farmer, or the truck grower, in an excellent position for keeping his land sheltered during a season when the direct rays of the sun are most destructive to the fertility of his land.

On stiff clayey soil, too compact for proper circulation of either air or water, green manure from cowpeas will improve the soil much quicker than stable manure; for in such impervious soils the stable manure, if plowed under deeply, may remain for a long time undecom-

posed and unfermented; hence, yielding very little, or none at all, of its plant foods to the succeeding crops. The best way of applying stable manure, no matter on what kind of soil, is to apply it on the surface of freshly plowed land, or land in loose condition, and then disk or harrow it in.

### COMMERCIAL FERTILIZERS.

Except for acid phosphate and the potash compounds, commercial fertilizers vary widely. The most important mineral fertilizer furnishing nitrogen is sodium nitrate, which is an inorganic form and immediately soluble in the soil moisture; hence at once available to the roots of plants, but also readily washed out of the soil during heavy rains. Cotton seed meal, tankage, dried blood, and bat guano are excellent and effective nitrogenous fertilizers, containing besides nitrogen also some phosphoric acid and potash. These forms are organic, but so readily acted on by the ferments of the soil that the nitrogen in them soon becomes available, and if the crop is not on the ground ready to utilize it at once, it may be wasted by leaching rains, especially on soils poor in humus. On such soil it is, therefore, advisable to apply such fertilizers in broken doses, never risking all in one application, but make several, as the plants become strong enough to use it. For example, if 500 pounds of cotton seed meal are to be applied to an acre of cabbages, 200 pounds may be applied shortly before transplanting into the open ground, and 300 pounds after the plants have shown decided growth; that is, about the time they show indication of beginning to head. In case of nitrates, which are immediately available for plant use, the last can be made even later. Potash salts and phosphates can be applied all at one time, and before planting, because these fertilizers unite with and are more readily held by the mineral ingredients of the soil; hence, cannot so easily be washed out. Nitrates, on the other hand, depend upon the humus for their maintenance in the soil.

*The Effect of Lime on the Soil.*—Lime has proven to be a powerful stimulant to the activity of all germ life necessary to a fertile soil, especially the bacterium that produces nodules on roots of leguminous plants.

*An experiment carried on at Cornell University with alfalfa on limed and unlimed soil, gives the following results as average for ten plats:

| | Yield of Hay. | Percentage of Nitrogen in Alfalfa. | Nitrates in Dry Soil at end of Experiment. Parts per Million. |
|---|---|---|---|
| Limed | 103.1 | 3.30 | 8.08 |
| Unlimed | 74.4 | 2.52 | 4.27 |

Lime acts on the humus: first, by preventing sourness; second, by making available its unavailable plant food; hence promoting its proper and useful decomposition. This power of the lime has been known for a long time and has been used as a special remedy in the reclamation of sour, peaty soils in northern Europe. Nor is lime a powerful and useful reagent for the organic matter of the soil only, but also for the mineral constituents. The stiff and tough clays, which cover so large an area of Texas, and which constitute our most unproductive and un-

*Cornell University Circular No. 7.

tillable soils, can be greatly ameliorated, both chemically and physically, by applications of lime. These clays contain compounds in which are locked, unavailable for the use of plants, such foods as potash and phosphates. These compounds are broken up by the lime. It is a matter of substitution. The lime takes the place of the potassium in its insoluble combinations. Probably the most representative figures on this point are those of Frear, of Pennsylvania, who found in nine soils of widely different character an increase after liming in the availability of potash ranging from 8 per cent on muck, to 55 per cent on red shale clay. The average for the nine soils was 23 per cent, equivalent to 60 pounds of potash per acre. This amount of potash is nearly equal to an application of 430 pounds of kainit. Besides this chemical action, there is connected with it a physical action, which consists in breaking up the tough clays and converting them into a more granular and porous structure, so that roots of plants can penetrate them, and air and water circulate through them.

The amount of lime to be applied per acre will naturally vary with the nature of the soil. Sour, peaty soils may need as much as 5 tons or more per acre. In northern Europe, where such soils are abundant, as much as 10 tons per acre have been used with benefit. For ordinary soils, not absolutely acid in their reaction, the Connecticut Experiment Station recommends about 400 pounds per acre, and this repeated at intervals of four years. Very heavy applications on soils not peaty are destructive to the humus, as this promotes a too rapid decomposition. The slaked lime may be applied broadcast, harrowed or disked into the land. For quick-lime, it is recommended to place it on top of the plowed ground in small heaps, convenient for distribution, cover with a thin layer of soil, and distribute so soon as slaking has taken place.

The soils of Texas that would be benefited by lime, outside of a few marshy places are the tough clays. They should be plowed deeply and immediately after plowing, while the soil is loose and mellow and before run together by rains, a thousand pounds to a ton per acre of either quick-lime or slaked lime should be applied to the land as a top dressing and thoroughly harrowed in. During the winter months the lime will have time to act on the clay, with which it has been mixed. The next spring the land should be planted to cowpeas for green manure.

## HUMUS.

The humus is the combustible ingredient of the soil. It owes its origin mainly to vegetable remains in the soil. In temperate and moist climates, the humus has a strong tendency to accumulate. In hot and dry climates the accumulation is very slow, or none at all, owing to too fast oxidation, or burning. This is the reason why the soils of the open prairie lands of the tropics are so uniformly lacking in humus, having a sandy or clayey texture and are of an ashy or light reddish color—indicative of low humus content. In the cold and humid countries of high latitudes, humus is not readily formed, but the partially decayed vegetation accumulates to an enormous thickness in the form of a waterlogged substance called "peat," which turns sour, is antiseptic to fermenting germ life, and unfit for most of our agricultural plants.

*Functions of the Humus.*—Humus is constantly changing by further

decomposition carried on to a great extent by fermenting bacterial life, which lives in and upon it. In these changes its proportional amounts of carbon and nitrogen increase progressively. Humus is the only substance in the soil that has the ability to unite with and hold the nitrates from leaching out. It is also the ingredient that absorbs and holds in store the water for the use of the growing vegetation. Humus gives to the soil that texture which is necessary to proper tilth; loosening and making more porous a soil too compact, and compacting a soil too porous. A soil without humus is "dead"; that is, it can neither be put in tilth proper for useful plants, nor can it furnish nourishment for them; even the bacterial life necessary to an agricultural soil will be excluded; hence, the common expression "dead" is more than figurative.

*Loss of Humus.*—Humus is lost: first, by constant decomposition, mostly due to bacterial ferments; second, by being used up by the crops and carried away in these; third, by direct combustion or burning—this takes place when the soil is exposed either by cultivation or by other causes to the direct rays of the sun in hot climates; fourth, by washing rains which more readily carry off its light particles than the heavier mineral matters.

The first of these destructive agencies act slowly and is necessary to agriculture; the two last act much faster and are destructive to agriculture.

The humus content of the uncultivated soil under a temperate and moist climate may accumulate until it constitutes a very large percentage of the surface soil; its proportion of nitrogen is, however, relatively low, amounting to only a fraction of one per cent, or to even a smaller percentage. In alluvial deposits of arid and warmer countries the humus content is much smaller; but its nitrogen content, as well as that of other available plant foods, is very much higher, reaching, for nitrogen, in some instances as high as twenty per cent. (Soils by Hilgard, p. 136.) When arid areas of this nature are put under cultivation and irrigation, the yield of crops is greater than on any other soil; but the loss of the humus, as well as its highly available plant foods, is also greater than in moist climates. This is due, not only to the fact that the irrigation water readily carries these highly soluble plant foods away, but the constant stirring of the soil after each irrigation to check the evaporation exposes the humus to burning. Agriculture in such regions must, therefore, be carried on with a constant view to conserve the humus.

In no civilized country has the destruction of the humus, and with it the soil in general, taken place to a more damaging degree than in the Southern States. In the older of these States large areas of once fertile lands have first been burnt out, then washed out. Our sandy loams of East Texas, wherever somewhat rolling, are fast going the same way. Even our black land prairies and alluvial bottom lands show a strong decrease in fertility after cultivation of scarcely more than one generation of farming. Cotton, which on these lands was produced at the rate of a bale or more than a bale per acre, is now producing only one-fourth as much.

The reasons why the Southern soils especially have suffered loss in fertility are not hard to account for. The cultivation of cotton, our most general crop, demands a constant stirring of the soil from April to

July, and in proportion as the soil becomes unproductive, even longer. Much of this stirring or cultivation of the soil is done when the temperature of the surface layer is for several hours of the day considerably higher than one hundred degrees Fahrenheit. The drier the atmosphere the greater is the necessity for this stirring to produce a surface mulch. Cotton is only to a partial extent rotated with corn, for which the cultivation is of the same nature, only of shorter duration. Besides the summer with its burning heat and occasional washing showers, the almost frost-free winters are also severe on the humus of our soils. During this season continued rains are not uncommon throughout the eastern portions of our State, and the soil, poor in humus, is especially washed and gullied.

The few cattle maintained on our farms are kept according to the ranch fashion; that is, rarely fed and kept in house, except occasionally, during severe winter storms; but allowed to roam at large mostly in wooded pastures, where their droppings are lost to the cultivated grounds.

*Conservation of the Humus.*—In many countries of Europe, where the larger portion of the land is in well-cared-for meadows and pastures, the cattle holding, as a consequence, is proportionately large. The cattle are fed under shelters, and the droppings gathered up and kept in store for the benefit of the crops. There the soil is growing richer every year, until it is a surprise to us to see what an abundant supply the tiller takes from a small area of land.

Humus accumulates very quickly in the sod lands of meadows and pastures, especially in pastures, where the droppings from the animals facilitate the increase. One of the principal rotations in countries, where sod-forming grasses readily take the land, is from cultivated fields into meadows, from meadows into pasture, then back again into field crops.

One of the principal attempts to amend the loss of fertility in our Southern soils is to use commercial fertilizer, which, as before stated, can at its best, on land lacking in humus, only stimulate the crop to which it is immediately applied. The lack of permanent value from commercial fertilizers is especially illustrated by the experiments at Rothamsted, England, where inquiries into the causes of loss and gain of soil fertility have been carried on more systematically, and for a longer time, than anywhere else. For example, in Experiment Station Bulletin No. 8, entitled "Six Lectures on the Investigations at Rothamsted Experiment Station," we have an account given of experiments with wheat continued for sixteen years. Analyses of the soil of each of the plats were made at the beginning and end of the period. The crops were weighed and analyzed each year. At the end of that period, plats that had received each year nitrogenous fertilizer only, either in the form of 400 pounds of ammonium salts to the acre, or 500 pounds of sodium nitrate to the acre, showed a loss of soil nitrogen varying from 17 to 216 pounds per acre. A plat having received ammonia alone gave an average of only 17 bushels of grain per acre, and had lost nitrogen, while one having received 14 tons of barnyard manure each year, gave an average yield of 31½ bushels of grain per acre, and had gained at the end of the period 173 pounds of soil nitrogen.

The best example of how short a time mineral nitrogenous fertilizer lasts in the soil was shown in a plat used as check, and which received

no fertilizer during the period. For thirteen years previous to this test, this same plat had received yearly 800 pounds of ammonium salts per acre, together with mixed mineral manures of super-phosphate and sulphate of potassium, and had averaged a yield of 40 bushels of wheat per acre. At the beginning of the sixteen-year period it was one of the richest in nitrogen; but at the end its soil analyses showed a loss of 173 pounds of nitrogen per acre. The average yield of grain for the period was only 13½ bushels per acre.

In commenting upon these experiments, the author of these lectures says concerning this plat: "A person imperfectly acquainted with the subject might suppose that this loss of nitrogen was due simply to the disappearance of the ammonium previously applied to the soil in such large quantities. This is not so. The loss of nitrogen in the soil, like its gain, is an action belonging to the nitrogenous organic matter in the soil; this is proved by the fact that the carbon (humus compounds) of the soil falls at the same time as the nitrogen, and to a much greater extent."

The Minnesota Experiment Station (Bulletin No. 70) conducted experiments for a series of eight years to determine the effect of cropping upon the fertility of the soil. Plat No. 1 was run continuously in wheat. In Plat No. 2 wheat was alternated with clover and oats; in Plat No. 3 the rotation was oats, clover, barley, corn. In regard to Plat No. 1 analyses revealed that the total loss of nitrogen per acre during the eight years was 1700 pounds per acre, only 350 pounds of which were carried off in the crops, and that 1350 pounds must have been leached out as nitrates or dissipated as gas. The loss of humus during that period amounted to 17,000 pounds per acre, or nearly a ton per year. On Plat No. 2, where two clover crops were raised in rotation with four crops of wheat and two crops of oats, the total loss of nitrogen was less than 800 pounds; hence, 900 pounds less than on Plat No. 1 with continuous wheat culture.

In his resume of the results, the author makes this statement: "As long as the nitrogen is in combination with and forms part of the humus, or the decaying animal and vegetable matter of the soil, it is in a stable form, but as soon as the humus decays, the nitrogen is liberated in various gaseous and soluble forms, which are easily lost from the soil."

These two examples are ample to show that soils constantly cropped are continuously losing their humus and with it their plant food, especially the nitrogen, and that this loss can only be restored by adding humus; and not by inorganic commercial fertilizers alone, as plainly shown in the first example. The second example also makes it evident that, where the one-crop system of agriculture is practiced, the loss is most rapid, and that by rotation of crops the loss is greatly impeded.

*Necessity for High Fertility for Truck Crops.*—No class of plants are more fastidious in regard to both the chemical and physical condition of the soil than our garden vegetables. In no other form of agriculture can a comparatively small piece of ground, if in proper condition, be made to give so large and valuable returns. Indeed, to use a simile, our garden plants, especially those from which we use the vegetative

parts, such as the roots, stems or the leaves, are like our domestic fowls: to produce the best, they must be "stuffed" with food.

The first requisite, then, preparatory to profitable market gardening is the enrichment of the soil, especially by increasing the humus. For this we have two special sources—the stable manure and the green manure from leguminous crops. The value of stable manure varies with the fodder upon which the animals have been fed, and the exposure of the droppings to leaching rains. Manure from feed pens, where cattle have been fattened on cotton seed meal and hulls, is, perhaps, the richest in plant food, if it has not been exposed to leaching rains.

Gardeners who live near the cities often have the opportunity to get manure from the livery stables and sweepings from the streets. It is a common practice of thrifty gardeners in such places never to return home with an empty wagon, but, instead, bring a load of manure from the city.

## THE COMPOST PILE.

In trucking fresh manure should not be heavily applied directly to the soil because of its slow decay and drying action, but should first be composted; that is, piled into square, flat-topped piles, several feet in thickness, to start the fermentation that is necessary both to make the plant food in it more available, and to improve the physical condition of the soil, to which it is to be applied. In composting it is profitable to alternate layers of manure with muck, which accumulates from washes in forest, turf from waste ground, and vegetable debris from swamps; in fact, all kinds of waste that undergoes rotting and decay. Such materials as peat and muck are powerful absorbents of ammonia gases, which are readily given off from fermenting manures. Besides the above mentioned earthy matters, which ought to be added in excess of the manures, if this be rich and readily fermentable, it is well to sprinkle in ashes, waste gypsum, or "land plaster," and mineral fertilizers, such as kainit and phosphates in the form of floats. Floats are ground phosphate rocks, insoluble in water, but become available after presence in the compost heap. These inorganic materials will also act as preservatives of the ammonia developed during the fermentation.

The fermentation in the composts is carried on by bacteria. There are two classes of these at work. In a loose compost pile a form called Aerobic, because it works in the presence of air, is at work throughout the entire pile, causing a too rapid and hot fermentation, by which much of the fertilizing ingredients are dissipated. In a well tramped or compacted compost pile, where the free access of air is excluded, another class of bacteria, called Anaerobic, carries on a fermentation, which is slower and gives rise to lower temperatures. While this latter gives rise to a temperature of about 100 degrees Fahrenheit, the Aerobic ferment may produce a temperature that rises to 160 degrees Fahrenheit. On the outer edges of the pile, where air has access, the Aerobic forms are always at work. Hence, to insure an even and useful fermentation, it is necessary to re-pile and thoroughly re-mix the ingredients of the compost pile, from time to time. Besides re-mixing and re-piling, watering by sprinkling is the proper means of controlling the temperature, which at its highest ought not rise over 130 degrees Fahrenheit. Watering must be so carefully attended to that the entire pile is uniformly moist

throughout. This, in a measure, drives the air out of the pores, yet no leaching or running off of the water must take place, in other words, the compost pile can be given all the water it can hold, but no more.

The amount of mineral fertilizer to be mixed with the manure should be regulated by the amount of the compost to be applied per acre. For example, if ten tons of compost are to be used per acre, and it is desirable in addition to give 500 pounds of ground phosphate rock, or floats, and an equal amount of kainit per acre, the proper amounts of these ingredients can be added to, and well mixed with each ten tons of compost.

Green manure will, however, be the main source from which the Texas farmer and gardener can cheaply and surely increase, not only the humus content of his soil, but also its nitrogenous plant food. Cowpeas are the best for this purpose, the reasons for which have already been mentioned. If the land should be lacking in any of the two most necessary mineral ingredients—potash and phosphorus—these can be applied directly as a fertilizer to the cowpeas, from which the succeeding crop will receive them in improved condition.

## ROTATION.

Rotation of crops has been considered a necessity to continued good yields for as long a time as systematic cultivation has existed. Experience has taught that the same crop, occupying the same ground year after year, sooner or later becomes a failure on that ground. Not to all crops do these failures come equally quickly; but all crops maintain higher yields if alternated with others of a different habit.

Many explanations for this phenomenon has been offered. An old and common explanation is that the same crop, taking continuously the same ingredients from the soil, soon depletes it of these particular substances, yet leaving enough of other substances to nourish a different crop to perfection. In view of plant physiology, this explanation is very unsatisfactory, for all of our cultivated crops use nearly the same ingredients in proportion so slightly different that it would not account for the pressing necessity of rotation. Furthermore, a crop grown on a soil for a long time may sicken and become unthrifty, when analysis may show that the soil has an abundance of all the plant foods. At the same time, no known disease may be discovered, except the general failure of the crop to grow as in the beginning.

"Recently the Minister of Agriculture in France has described the failure of crops in old, highly enriched gardens of that country. Since the failure has never been shown to be due to bacterial or fungus disease, it may be assumed that the cause of the difficulty is located in the soil. The analysis of such soils shows that they are abundantly supplied with plant nutrients; yet there is a notable failure in the attempt to grow crops which at one time flourished on these soils."*

Although, as already stated, the necessity for the rotation of crops has been known for a long time, the cause for the necessity has received little or no investigation by plant physiologists. The Bureau of Soils in Washington has, however, of late years taken up this investigation and already published valuable data on the results. The conclusions

*Bulletin No. 40, Bureau of Soils, United States Department of Agriculture, Washington, D. C.

arrived at are, that the gradual decrease in the yield and the final unthriftiness of a crop, grown successively on the same ground, are due to excretions from the roots of the plants. These excretions act upon the succeeding crops of the same kind, or physiologically similar kinds of plants, as a poison. A crop of a different kind of plants neutralizes, or destroys, this poison. The same is accomplished by a dressing of lime or organic manures, such as stable manure or a crop of green manure plowed under; or any organic commercial fertilizer, such as cotton seed meal.

"An addition of complete mineral fertilizers, in an amount greater than the first crop withdrew, is unable to maintain the original yield."*

The authors of the above named bulletin state that the poisonous properties left in the soil by the first crop were even removed or neutralized by the addition of carbon black, which contains no plant food.

## TERRACING SLOPING LAND.

Terraces lessen erosion. It is a rare thing to see terraced land in Texas, although a large number of farms, embracing all classes of soils, are being ruined by washing and gullying, wherever the land is somewhat sloping. It is not uncommon, even on the black waxy soils of North Texas, to see the barren subsoil on the hills and slopes exposed, the surface soil having been carried away during heavy showers. Under such conditions, soil improvement is out of the question, until the land has been carefully terraced.

An instrument so simple that any man, who possesses a hammer and a saw, can make one, is all that is needed with which to lay out terraces. The instrument is a frame made of light but strong wood and well fitted together. It consists of five pieces; a beam at the top, to which is fastened two legs, with a spread at the bottom of ten to twelve feet, according to choice, and two braces to hold the legs securely in position. To the horizontal beam a spirit level is fastened. The height of the frame may be 3½ to 4 feet. On moderately sloping land, the former height is the more convenient, because the height of the frame is a convenient measure by which to determine the elevation of one terrance above the other. (Figure 1.)

Before beginning the work of laying out the terraces, all minor unevenness, due to rows or furrows, should be smoothed down. The laying out of the terraces is done as follows: The leveling frame is placed where the head of the first terrace is to be (the lower part of the slope), and in the direction in which the terrace is to run. The front foot is swung to and fro until the spirit level shows that the frame stands horizontally; it is then moved forward so that the rear foot is placed in the track of the front foot; and so on continuously to the end of the terrace. Meanwhile, a boy with a hoe is to follow, making plainly visible marks of the tracks of the frame, each time this is moved forward. The second terrace is located at either end of the first terrance by placing the front foot of the frame in the last track, or by returning to the first track, placing it perpendicularly to the direction of the first terrace, then raising the rear part until the frame is level, and sighting

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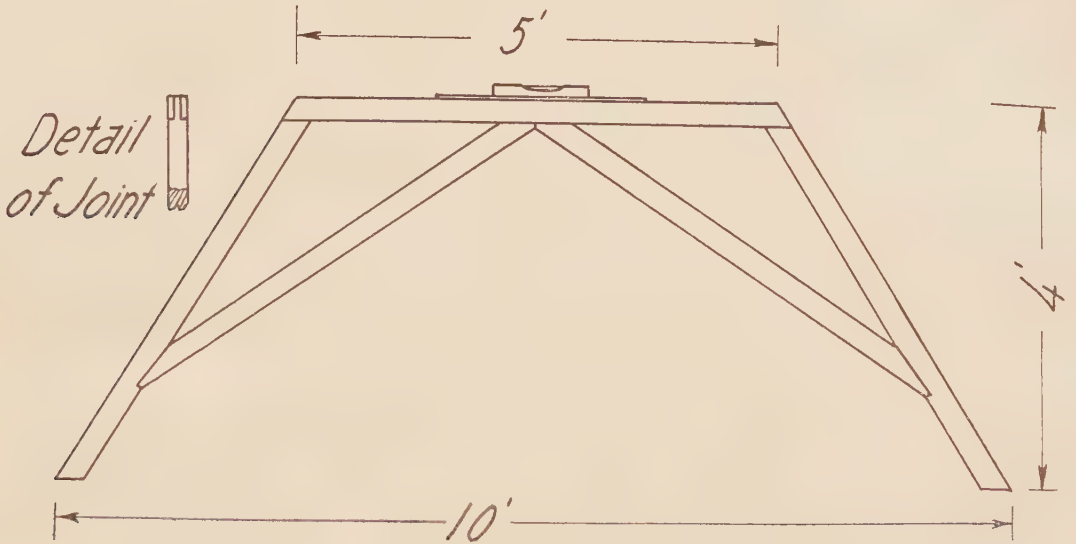


FIGURE 1

up hill along the beam, selecting the spot on the ground which shows an elevation equal to the height of the frame as head of the next terrace. After locating the terraces, it is convenient to take a Georgia stock with bull tongue and plow a furrow connecting the marks made with the hoe. The foundation for the terrace is made with a two-horse turning plow, throwing two furrows together on the marks made by the bull tongue. After this foundation is made, the terraces should be finished with the shovel or spade, taking all the dirt for this purpose from the lower side only; because any digging or removal of dirt from the upper side seriously endangers the terrace. The height of the terrace should be sufficient to prevent the water from flowing over at any point between the ends. In building, the dirt should be well packed and firmed by tramping; for, if loose, it will be unable to resist the pressure of the water accumulating during heavy showers. Where the terrace crosses gulches, it may be necessary to put a rock or plank wall behind the dirt to support it. Gulches crossing the land between the terraces should be packed full of brush; and, if deep, logs may be placed on the top of the brush to keep it firmly pressed down. This brush will stop the silt carried by the rushing water, and the gulch will soon fill up and give place to good level land enriched in humus from the decayed brush and logs. The terraces will need constant mending and attention at least for the two first years, while the mass of the water rushes against them. But as the dirt is being constantly deposited from the terrace towards the higher ground in the rear, the land becomes more and more level, a larger surface of land carries the water, and the strain upon the terrace becomes less each year, until the water flows only towards the ends so quietly that no more silt is carried off the land. The water must at no time be allowed to cross the terraces, as this will result in breaking through, and in the loss of much valuable soil. The length of a terrace must not be made so great that the outflow of the water cannot be accommodated at the ends without crossing.

In plowing and planting terraced land, it is necessary to work from each terrace towards the center; that is, go around the land so that each row may carry its own water to the ends. The fertility of washed and worn land increases perceptibly after terracing, even though manure may not be applied. First the lower parts of the land come up in yield, then the higher, as the silt is deposited or left in place undisturbed by the water.

### FORCING FRAMES.

In the larger part of the eastern half of Texas two crops of the more hardy vegetables can be raised in the year; namely, one in the spring and one in the fall. In the Gulf region the seasons of these two crops overlap; because there, the temperature of the winter months is also well suited to gardening. Outside of the Gulf region both seasons are short. In June the temperature is liable to become so high as to impair both the quality and the quantity of the early class of vegetables, and the latter part of December is liable to bring too severe frosts. These facts, together with the advantage of early market, make an early start necessary. To obtain this, the seed of all plants to be transplanted must be sown in hot beds, six weeks to two months before

time for transplanting into the open field. Besides hot beds, in which the young plants are allowed to remain only until they have set two to three leaves beyond the seed leaves, cold beds are needed, into which the plantlets are transplanted, so as to harden them for the final transplanting into the open field.

A hot bed is a rectangular framework constructed over an excavation 12 to 18 inches deep—a convenient width being 6 feet—and the length may be according to requirement. The south side of the framework may be a foot or more above the surface, while the north side should be 10 to 12 inches higher, so that with a cover on, the frame would have the pitch and appearance of a lean-to-roof. The wall of the frame, or bed, is extended to the bottom of the excavation; the whole must be tightly made so as to exclude any cold current of air from the outside. The top must be furnished with rafters set in at proper distances to accommodate the sashes, which ought to be about 3 feet wide, if of glass. Instead of glass, the sashes may be covered with cotton cloth, saturated with pure, raw linseed oil. Before using such cloth, care must be taken that the linseed oil is thoroughly dried, as the fumes given off by the too fresh oils are liable to kill or severely injure the plants, when enclosed in such an atmosphere. For further protection against cold, it is well to bank the earth up around the walls of the bed. The drainage from the excavation is to be such that no accumulation of water takes place in the bottom. (Figure 2.)

The old, and perhaps the safest and cheapest way of heating the hot bed is by means of fermenting horse manure placed in the bottom. For this purpose it is best to make timely preparation by piling up fresh and easily fermentable horse manure in the form of a compost pile; allow it to start the fermentation, and as soon as this has become quite evident, fill the excavation in the bottom of the hot frame from this pile, compacting the manure by thoroughly tramping it in. It is also necessary that it be carefully leveled and evenly moistened throughout, so that the fermentation may start evenly all over. For that same purpose it also is necessary that the manure be well mixed and of the same consistency. The thickness of the layer of manure, after packing, may be from 10 to 14 inches. The depth of the excavation as well as the depth of layer of fermenting manure should naturally vary with the severity and length of the freezing season. For regions with zero weather a layer of manure 18 to 20 inches in thickness may be necessary. After an interval of a week to ten days, the temperature of the manure may rise to 120 degrees, or even 130 degrees Fahrenheit. It should then be moistened, if showing a tendency to dryness, and immediately covered with a layer 6 to 8 inches thick of good mellow sandy loam, well enriched with rotten compost, in which to sow the seeds. This layer should also be moderately well packed, so that the roots of the young plants may take a firm hold in the soil.

When the temperature of the heating manure has cooled to about 80 degrees Fahrenheit, as shown by the soil thermometer when plunged into it, the bed is ready for the seed.

Besides heating hot beds in the above manner, it can also be done cheaply by means of hot pipes. For this purpose a furnace is constructed outside the frame and sunk about two feet below the level of the surface. From this furnace two lines of 4 to 6 inch vitrified sewer pipe are placed

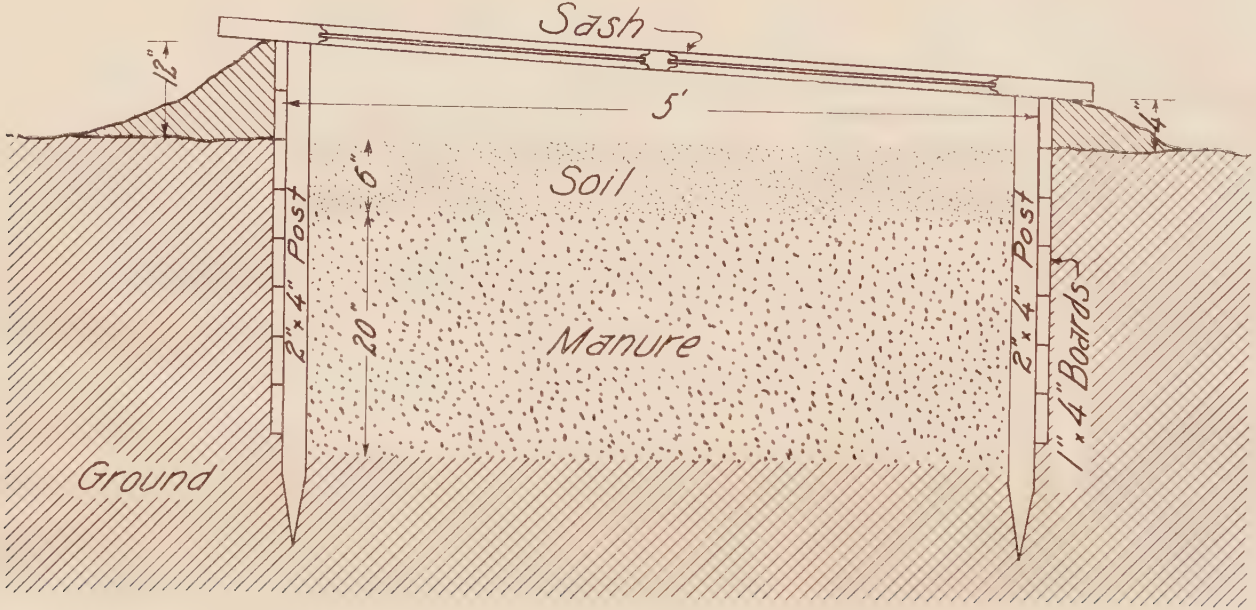


FIGURE 2

obliquely through the soil to the opposite end of the frame, where vent to the smoke from the furnace is given on the outside of the frame. The pipes should run parallel at equal distances from the walls of the bed and each other, with a slant upward from the furnace to the chimney at the other end of the frame. They should be covered with a layer of earth sufficiently deep to secure as nearly as possible an equal distribution of the heat.

The heat secured from this apparatus is much more difficult to control than that from fermenting manure, but the construction may be made permanent with only the removal of the layer of earth, in which the seeds are sown for each new crop. (Figure 3.)

Cold frames are constructed after the same plan as hot frames, with the exception that the whole frame is on the surface of the ground, with no arrangement for heating.

The seed should be sown in drills 4 to 6 inches apart, and $\frac{1}{8}$ to $\frac{1}{2}$ inch deep, directly on the earth in hot frame; or they may be sown broadcast in flat boxes, 14 inches wide and 4 inches deep. If this latter method, which is a good one, is pursued, the layer of dirt on the top of the manure in the hot frame need not be over 4 inches thick.

*Care of the Hot Bed.*—The most general danger to young seedlings in the hot bed comes from the so-called "damping-off" fungus. This is most liable to attack the seedlings soon after germination. It attacks the plants at the surface of the ground, causing the affected parts to wilt and rot, and the young plants to fall down. The disease spreads so fast that in a few hours a whole bed of plants may be killed. It is usually associated with the following conditions of the bed: Excessive moisture, too high temperature, lack of light and airiness, and too crowded stand. Prevention is the exclusion of these conditions; hence, moderate watering, airing and sunning, whenever the temperature will permit it, and the sashes never closed down, except to prevent chilling or freezing of the plants.

Dusting the surface of the soil with a mixture of flour of sulphur and lime immediately after sowing has shown good effects in keeping off this fungus. For similar effect, it is also recommended to cover the soil after sowing with a thin layer of fine sharp sand. Solutions of the following fungicides are given by Duggar in his book "Fungus Diseases" as practical remedies: One-half pint formalin dissolved in 625 gallons of water, or 1 pound of copper sulphate dissolved in 625 gallons of water. These solutions are sufficiently weak that the young plants can be sprayed with them without harm. Either solution can be used in case the disease should show itself in any part of the bed. But as prevention is much surer than cure, it is suggested that the solutions be made twice to three times as strong and used immediately after planting, as a light spray to moisten the surface of the soil—this application to be made only once.

For our hardier vegetables, such as cabbages and their class, that can stand the climate in the open field at early corn-planting time, sowing in the hot beds should be done about six weeks previous to that time. For example, if corn-planting be considered safe about the 20th of February, sowing of cabbage seed may be done during the first week of January.

As soon as the young seedlings are strong enough for transplanting from the hot bed to the cold frame, this must be attended to at once,

since remaining there in a crowded condition will cause them to grow spindling and weak and make them subject to damping-off.

Transplanting must be very carefully done. The best way is to lightly water the plant bed before starting, so as to cause the dirt to adhere better to the young roots. The young plants must be protected from evaporation during the interval between taking up and resetting. They should not be pulled, but lifted out of the ground by a narrow trowel, or for lack of such, by means of an ordinary table knife inserted under their roots. In the cold frame they should be set somewhat deeper than they stood in the hot bed, and, if tall and spindling, deep enough to give them a stem of normal height. Their distance apart in the cold frame ought to be such that, if necessary, the ground between them can be stirred with a pointed hoe, or hand weeder; hence, they should be planted in rows 6 inches apart with 3 inches between the plants in the row.

*Transplanting into Pots.*—One of the best and quickest methods in the long run, is to pot off each individual plant into two and one-half inch flower pots, and sink these pots into the bed of the cold frame instead of setting the plants directly into this bed. This method has several advantages. First, there will be no further disturbing and mangling of roots in transplanting from the cold frame to the open field; second, final transplanting can be done with more independence of moisture and weather conditions at the time; third, the safety with which the plants can be handled makes the transplanting much quicker.

Potting off the young plants is also done with greater speed and safety than transplanting directly into cold frames, especially if the plants have been started in flat boxes or seedling trays. A table may be improvised, under shelter, if necessary. On this table all things necessary can be arranged within easy reach of the workers, such as a box of plants, an empty box in which to place the potted plants, and pots filled with earth ready for the potting. Three persons can pot off and place in the cold frame many thousand plants in a day, dividing the work as follows: One to do the potting and sprinkling after potting; another to fill the empty pots with dirt, and remove them when ready for the cold frame; a third to sink the pots in neat and close rows into the bed of the cold frame. For potting, mellow and well enriched earth should be used, and this merely moist, so as not to stick to the hands. The pot can be filled brim full, merely by scooping it into the dirt and then leveling it with the brim. With the finger, the potter makes a hole in the center large enough to receive the roots of the plantlet, after which he fills the dirt gently against the rootlets, finally pressing it firmly into the pot and around the roots, leaving $\frac{1}{8}$ to $\frac{1}{4}$ of an inch of the upper part of the pot empty of dirt, as a receptacle for the water.

As fast as the plants are put in the cold frame, whether potted or directly transplanted into the bed, they should be sprinkled with water and covered by the sashes. If these be glass, shading from the direct sunlight is necessary until the plants show by their rigidity that they have recuperated from the transplanting.

Potting is advisable for all sorts of plants that are to be forced for earliness. In case of melons and cucumbers, the seed should be planted directly in the pots. In pots of the above size, several melon seed may be planted to secure a stand, but after germination only one plant in each pot should be allowed to develop.

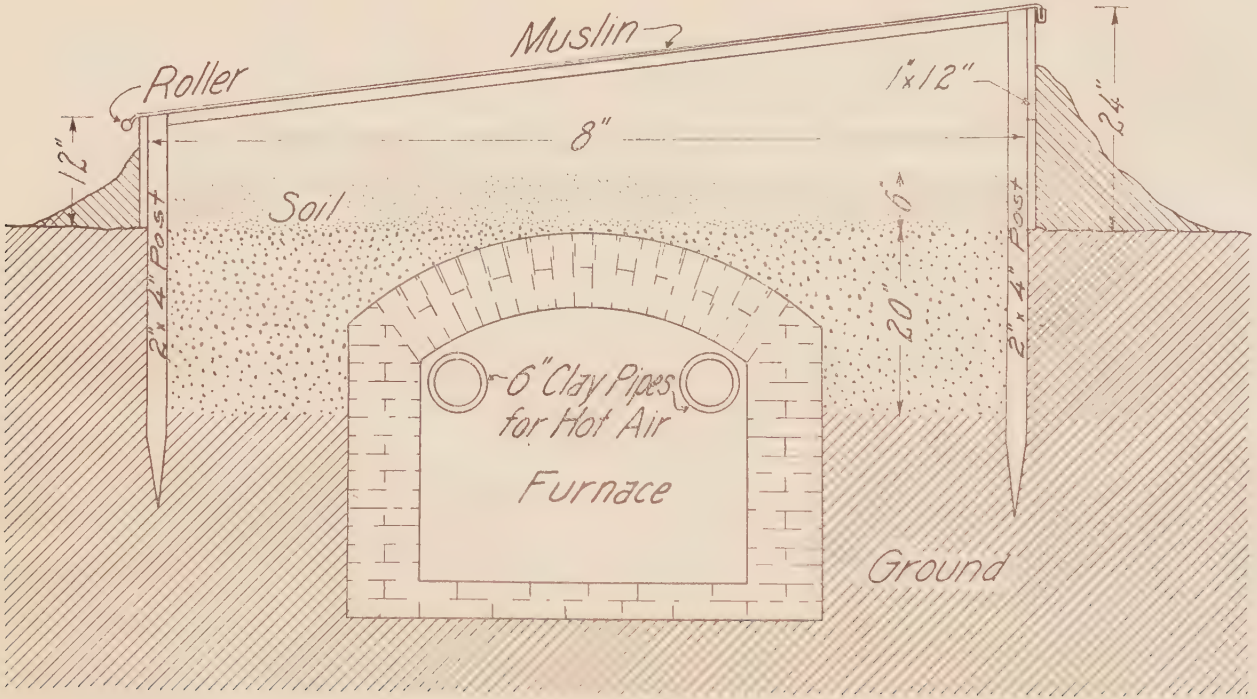
Muslin
Roller
1"x12"
24"
12"
8"
Soil
6"
20"
2"x4" Post
2"x4" Post
6" Clay Pipes
for Hot Air
Furnace
Ground

FIGURE 3

As the plant grows, it soon fills the entire ball of dirt in the pot with roots, thus firmly binding the soil together. The roots may, if the plant is forced to occupy the pot too long, form a dense lining between the ball of dirt and the wall of the pot. In transplanting to the open ground this lining should be broken or removed at its lower parts; otherwise it is liable to become a hindrance to a good root system. Potted plants should be transplanted to the open ground before such a root lining develops.

Transplanting from the pots to the open ground is easily and safely done, even if the weather is somewhat dry and sunny, provided the soil is in good, mellow tilth, and has the proper amount of moisture. The pots can be brought to the field on low sleds, and from these carried in seedling trays, or flat boxes, and distributed along the rows where the plants are to be set out. One person can do the distributing, while another does the planting. By inverting the pot, holding it with one hand and gently tapping it on the inverted rim with the other, or with a light garden trowel, the ball of dirt readily slips out with the roots intact and undisturbed. With the hand, or a trowel, a hole can be made with one stroke to receive the ball of dirt, after which it is gently covered and firmly pressed into the ground. In sunny weather a proper precaution is to have water in the field with which to keep the plants properly moist, while waiting for their turn to be transplanted. If it is very dry and hot, as in the early fall, a cloth for covering the plants from the rays of the sun may be necessary, as additional protection, while waiting for planting.

Several other contrivances, besides pots, have been tried, to avoid injury to the plants in transplanting into the open field, but none are as feasible as pots. Nor are they cheaper in the long run, since the pots, if handled with only moderate care, are a permanent investment.

Pots of the size mentioned can be obtained in the State for about $4.50 per thousand. If a community of truck farmers club together and order by carload lots, they can certainly get them cheaper; besides, they will escape the cost of crating, which, if not very carefully done, brings about great loss through breakage.

## THE VEGETABLES OF THE MUSTARD FAMILY.

*Cabbage and Cauliflower.*—The cultivated cabbage is supposed to be a descendent of *Brasica oleraceae*, a weed growing wild, here and there, on the Atlantic and Mediterranean coasts of Europe. Its cultivation began in prehistoric times. Its long duration, together with the proclivity on the part of the plant to form "sports" or mutants, must be held responsible for the numerous and widely different forms that we today cultivate as descendents from this simple wild weed. About the most distinct of these forms are: the headed cabbage; the cauliflower, and *broccoli;* the Brussels sprouts; the kale, and the collard; and, finally, the kohl-rabi. Each of these is again differentiated into numerous varieties, according to form, earliness, size and color. All of them delight in similar conditions as regards soil and climate; namely, a moist, rich, and somewhat heavier soil than for most other vegetables. All prefer a moderately low temperature, and can stand some frost without injury, except the cauliflower, which is easily spoiled, if frost occurs

at the time of heading. Besides needing an even supply of moisture, a soil well stocked with humus and an abundance of available plant food is necessary for both quantity and quality of the crop. The best preparation of the land is to give it either a heavy dressing of stable manure, or plow under a heavy crop of cowpeas during the preceding season. The cabbages are among the greatest feeders of all our vegetables; hence, the soil can scarcely be made too rich in plant food. Even on a very rich soil, the crop can be materially increased by applications of commercial fertilizers. It is especially beneficial in stimulating the growth to give the land a top-dressing of 80 to 100 pounds of sodium nitrate per acre, at the time when the plants commence to show the first signs of heading. If we depended solely on commercial fertilizers, 2000 to 3000 pounds would be needed per acre. Harold Hume, in Florida Bulletin No. 59, recommends for cauliflower the following amounts of fertilizers per acre: "Two hundred and fifty pounds of nitrate of soda and 400 pounds of cotton seed meal, 600 pounds of acid phosphate and 400 pounds of high-grade sulphate of potash, and sufficient stable manure to cover the ground from one to one and one-half inches deep. If the soil is rich in humus, the stable manure may be omitted, in which case the amounts of commercial fertilizers should be slightly increased."

This amount of commercial fertilizers would give the following net ingredients of plant food per acre:

| | |
|---|---|
| Nitrogen | 67 pounds. |
| Phosphoric acid | 106 pounds. |
| Potash | 200 pounds. |

In the same bulletin an acre-crop of cauliflower weighing 13,560 pounds is calculated to have removed from the land:

| | |
|---|---|
| Nitrogen | 56.62 pounds. |
| Phosphoric acid | 79.69 pounds. |
| Potash | 156.81 pounds. |

By comparison, it will be seen that the above applications of commercial fertilizers would contain more plant food than a very heavy crop of cauliflowers would remove; thus ignoring the fact that a soil rich in humus would, under ordinary circumstances, need no more plant food from the outside than enough to stimulate the early growth of the crop, and perhaps some nitrate at the time of heading up, so as to secure an even and early maturity on the part of all plants.

It is not unlikely that one-half of the above amount of commercial fertilizers, when applied at the proper time upon such land, would produce an equally good crop of cauliflower. It must be remembered that, in profitable truck growing, the soil must be able to do for the plant what the good pasture, in cattle feeding, does for the animal; some concentrated and easily digestible artificial food to give a vigorous start, the pasture to sustain the growth, and again an extra ration of concentrated food to finish it for the market.

During seasons of favorable moisture conditions, or where irrigation can be had, two crops of cabbages can be raised throughout a large portion of the southern half of Texas; namely, a fall crop and a spring

crop. Seed for the fall crop should be sown in cold frames during the latter part of August or early part of September. By proper protection from the severe sun of that season and proper watering, the plants will be ready for the open ground in about six weeks, especially if they be transplanted with good care from the seedling bed into pots. The proper distance for both early cabbages and cauliflowers is three feet between the rows and two feet apart in the row, which requires 7260 plants to the acre. It takes about four ounces of cabbage seed to secure this number and of cauliflowers a little over two ounces, since we usually count 3500 plants from each ounce of good cauliflower seed. In buying seed for a certain acreage it is best to be moderately liberal, since all young plants showing weakness should be discarded. The best cauliflower seed is imported from Denmark. Cauliflower seed is the costliest of all our vegetable seed, being quoted by the seedhouses at about $10 per ounce.

The spring crop of cabbages and cauliflowers should be sown in hot beds about the first of January, or even earlier for the extreme southern part of Texas, where transplanting into the open field may be made earlier than farther north; or for any part of the State, about six weeks before early corn planting in that part. In case of both cabbages and cauliflowers, earliness is a prime requisite for successful varieties, since both the fall and the spring season are too short for the later but larger varieties. In the southwestern part of the State, however, the frosts are scarcely severe enough at any time to injure the late varieties of cabbages which need a much longer season to mature. Both cabbages and cauliflowers are very sensitive to too high temperature, and are easily checked in their growth by it. High temperature results in loss, both to the quantity and the quality of the crop. The heads of cauliflowers when formed under high temperature become tough, loose, branching, and leafy; while the color, instead of creamy-white, becomes purple, and the flavor acrid. As soon as the cauliflower commences to form its head, it is necessary to tie the leaves up over it, so as to protect it from the direct sun, which, at any season, will produce the above mentioned defects in the cauliflowers. The head, or flower, as it is sometimes called, is also very sensitive to frost, the slightest touch of which kills it and produces decay. Before heading, the cauliflower is moderately resistant to frost, yet not so much as the cabbage.

The five best early varieties of cabbage, as shown by the variety test at the Beeville State Experiment Station during 1899-1900, were: Early Jersey Wakefield, Charleston Wakefield, Early Summer, Stein's Flat Dutch, and All Seasons. Of cauliflowers there are also both early and late varieties; but the most popular, and perhaps the surest, is the Early Dwarf Erfurt. This, and the Early Snowball, are raised almost to the exclusion of the other varieties, by those who make a specialty of growing cauliflowers in America.

In cauliflowers, as in cabbages, the plants of the same variety ripen at slightly different periods; some earlier, some a few days later, necessitating several cuttings. The proper market size is a head 4 to 6 inches in diameter. The cutting should take place in dry weather, after the dew is off the plants, as moisture in the pack is liable to cause decay. In cutting, the outer loose leaves are removed, and the inner

cut back to a level with the top of the head. In packing, a good precaution is to wrap each head in a sheet of white wrapping paper. Boxes used for shipping lettuce are also suitable for shipping cauliflowers.

*Kohl-Rabi.*—The kohl-rabi is, as before stated, a linear descendant of *Brassica oleraceae,* and has come down to us in a line parallel to those of the headed cabbage and cauliflower. In the cabbage it is the terminal bud of the plant that develops into a storehouse for reserve food; in the cauliflower the stem with its numerous branches becoming flat and fan-like, dwarfed, and engorged with reserve food; while in the kohl-rabi, the stem has assumed the form of a solid globe, the interior of which is filled with juicy, tender meat, having a flavor very similar to the interior part of the cabbage head. This meat is surrounded by a strong, fibrous rind. The exterior of the rind, or bark, is smooth and glaucous, as are the leaves, varying in color from green to purple, according to the variety. Upon this globular stem the leaves are borne, the lower somewhat remote from each other; the upper more closely arranged. In the preparation for cooking the rind must be removed. The kohlrabi when prepared and flavored with meat, as for the cabbage, is fully its equal, both in palatability and nourishing qualities.

The seed may be sown in hot beds and the young plants transplanted into the open field exactly as in the case of cabbages; or the seed may be sown with a garden drill directly into the open ground, as in the case of turnips. The plants are very resistant to frost, even more so than cabbages. An ounce of seed will produce about 2,000 plants and costs from fifteen to twenty cents; hence, cheap enough to be drilled into the open ground and thinned to proper stand, which is about the same as for turnips, or eight to ten inches apart in the drill. As to soil and cultivation, the requirements are the same as for cabbage and cauliflower. But the kohl-rabi is much earlier than either of these, being large enough for market in two and one-half to three months. The kohl-rabi will, on rich soil, grow to a large size, but is usually harvested before full grown, as the meat is more tender and juicy at the earlier date, although it does not show the tendency to become pithy as soon as most varieties of turnips do. The kohl-rabi is suitable both for fall and spring crops throughout all latitudes of Texas. It has also the advantage of being easily shipped and stored, because of its tough, fibrous rind. There are several varieties of kohl-rabi, but the most commonly planted are the White and the Purple Vienna. These two are also about the earliest.

*Brussels Sprouts.*—This vegetable is little cultivated in America, but more extensively in Europe. Its cultivation is in all respects similar to that of the ordinary cabbage; so are also the requirements upon soil and season. This plant produces a stout stem, bearing large, drooping leaves, after the manner of the collard. In the axils of these leaves, large buds, or rather small cabbage-like heads, are developed, in a strong plant, to the number of twenty or more. As the heads become large enough to be crowded by the leaf stems, these should be carefully broken off at the base, thus leaving at last only a rosette of leaves at the top. It is also well, when a good many heads have developed, to pinch out the terminal bud so as to stop the lengthening of the stem and throw the activity of growth into the heads. Brussels sprouts is a slow growing plant, need-

ing five months or more from date of sowing until the first heads are ready for harvest. For this reason it is only adapted to the southwestern Gulfcoast region. There it should be sown in cold frames during the latter part of August, or early in September, and treated in all respects as a crop of fall cabbages. The plant attains a height of twenty to twenty-four inches, when full grown, and needs the same room in the open field as the cabbage.

*The Rutabaga and the Turnip.*—The rutabaga and the turnip are descendants from two species of *Brassica;* that is, they are close relatives of the parent form of the cabbage races. The rutabaga differ from the turnips in producing a root of a more generally oval or elongated form, with yellowish meat of a richer and sweeter flavor than that of the turnip, and in which the pungent principle of the turnip is absent. The leaves of the rutabaga are smooth and glaucous, as in the cabbage species; while in the turnip the leaf-surface is beset with short, stiff hairs, not glaucous or covered with bloom, or having a waxy gloss on the surface. As in the cabbage, their parents were natives of cold, moist climates. The soil to which they are best adapted is also the same as for the cabbages; hence, they are plants that in our latitudes must be raised during the fall, winter and spring months. The seed is sown directly in the open ground, from the latter part of August to the middle of September, for fall crop; and during the middle of February to the middle of March for spring crop. In the case of turnips, the seed is frequently sown broadcast, in the fall, on land well prepared and manured. A spot of ground previously enriched by penning cattle or sheep upon is frequently selected for this purpose, on the ordinary farms. For spring crop, when early weeds are liable to come into competition with the crop, it is safest to sow in drills and thin the plants, so as to leave a space of 6 to 8 inches between each two plants, all according to the size of the variety.

The varieties of each class are very numerous, both in regard to size, form, flavor, and earliness; this is especially so for the turnips. The turnips are easily grown, being less exacting as to cultivation than the rutabagas, which are more easily stunted by neglect and lack of moisture. Rutabagas require also a longer season to reach full size; so that the southern part of the State, where the fall sown crop may have the whole winter in which to grow, is climatically well suited to it. In Europe the rutabaga is especially grown for the table; while the turnip is mostly grown for cattle feed; although it is not superior in that respect to the rutabaga, except as a quicker growth. In Texas rutabagas are more seldom raised than the turnips, although much superior to the turnips both in nutritive value and flavor, as well as equal or even superior in yield per acre.

Having a longer season of growth, the rutabaga is slower in becoming pithy or tough, provided the growth is continuous. If the growth is stopped by lack of moisture, the meat becomes fibrous and hard, and on the resumption of growth after renewal moisture, the plant is liable to go into making stems and flowers, when its meat deteriorates in quality. Both turnips and rutabagas are quite exempt from the diseases and insect pests that so commonly attack the cabbages.

The price of seed is the same for both; namely, from 60 cents to 70

cents per pound. The same amount of seed per acre is required for each; namely, about two pounds, when sown in the drill.

*Radishes.*—Radishes, as the form of their leaves and flowers and the pungent flavor of their roots indicate, belong also to the same family as the *Brassica,* but to a different genus of that family. The original home of the cultivated radish is in some doubt, but it is thought that some varieties have come from the wild radish of Europe; others from an Asiatic species of the same genus; namely, *Raphanus.* Radishes are generally classed as winter and spring varieties. The spring varieties reach their full size in a month or six weeks from sowing, then turn pithy and become useless. The winter radishes continue their growth for a much longer time and remain crisp and tender much longer. They are also generally much larger than the spring varieties. The best of all our winter varieties is the Rose-colored China, distinguished by its white, crisp, and mild flavored meat. It keeps tender throughout the entire fall and winter until the warmth of the spring forces it into growth for flowering. It is a large variety, of cylindrical form, with smooth, rose-colored skin. It ought to become popular in the Northern markets, as it can easily be made ready for the Christmas trade.

Radishes prefer a well enriched sandy loam to produce smooth and uniform roots.

*Horse-Radish.*—The horse-radish is also a member of the same family as the vegetables just described; namely, the so-called mustard family. The horse-radish is not much grown in Texas; yet frequent inquiries concerning the culture of this plant come to the Experiment Station.

The horse-radish is not only a highly esteemed condiment with meats, fish and oysters, but also a stimulator of good appetite and digestion, and is eminently suited as a table relish during our spring season.

Horse-radish is readily grown in any soil not too stiff or too sandy, but moderately moist and well supplied with humus. As fertilizers it requires an abundance of potash and phosphorus, but not so much nitrogen. The proportion of fertilizers recommended is given as ten per cent of potash, seven per cent of phosphorus, and four per cent of nitrogen. Six hundred pounds made up of such a mixture can profitably be applied to an acre. In poor and dry soil the roots become small and lacking in succulency; in too wet soil the flavor becomes inferior. In short, any good garden soil, rich in humus, with a little addition of potash and acid phosphate, will produce a good crop of horse-radish.

Like the other members of the same family, the horse-radish is native of a cool climate, being wild in England, and has even become wild in moist, rich woodlands in New York and the New England States.

The horse-radish is mostly propagated from cuttings of the roots, and for this the larger side branches formed at the base of the tap-root are used. Such cuttings ought to be no less than one-quarter of an inch in diameter and four to five inches long, planted with a dibble, in a slanting position, and covered with three inches of soil above the tops. The usual distance given the cuttings is 12 inches apart in the rows, and the rows far enough apart for the cultivator. Planting is made early in September, in good, mellow, moist soil. As the weather cools the

growth becomes more vigorous. Cultivation should be given after every rain, as in the case of other vegetables. In the Northern States the cuttings are planted one fall and dug after the second fall; but in the South, where the growth would continue with very little interruption during the entire winter, the roots would be large enough for use the next spring. The root-cuttings to be used for planting the next fall may be kept healed-in in a pit, where the soil is well drained and sheltered from too high a temperature.

The early method of raising horse-radishes consisted in planting the bed once, and at harvest cutting the roots off, leaving the tap-rot with its laterals in the ground for a new start. By this method the plants become too crowded after the removal of a few crops, and the tissues hard and stringy. The better way is to cultivate the plant as an annual.

*Other Vegetables of the Mustard, or Cabbage Family.*—Chief among the remaining vegetables of this family are those cultivated for salads; namely, the mustard and the kale, each of which produce several varieties, some tall, some dwarfed, some with leaves plain, others with them curled. They are all hardy winter plants and grow under the same conditions and culture as described for the other members of this family.

An important salad plant is the cress, or water-cress, so-called because in its nativity (Northern and Middle Europe) it grows wild along edges of watercourses. It will also grow on any rich, moist upland soil during the cool season of the year; hence, we have varieties called upland cress. The flavor of cress is much more delicate than that of mustard. The plant, besides its excellent flavor as a salad dish, is medicinal, being antiscorbutic to a high degree. The cultivation of the upland cress is the same for mustard and kale.

### SOLANACEAE OR NIGHTSHADE FAMILY.

From this group of plants we have received as the foremost in value *Solanum tuberosum,* or the Irish potato; besides the tomato, the egg plant, and the peppers.

*Irish Potato.*—The Irish potato is the premier American vegetable. The native home of the Irish potato is the high land of the Andes mountains, especially in the region of Chile and Peru. Here the Spaniards found this plant already well developed through a long cultivation by the natives. The wild specimens occasionally met with in the native country produce small, watery tubers, and always have white, sweet-smelling flowers. The potato was brought to Spain soon after the year 1560, and is now cultivated all over the world, wherever the temperature is not too extreme—in Norway the plant is cultivated even to the 70th degree N. Lat.

The Irish potato prefers a sandy loam of good depth and rich in organic matter. The best preparation of the soil is to precede the potatoes with a crop of cowpeas. This crop should be plowed under in the previous fall, as soon as the first pods have reached full size. Even if the cowpeas are removed for hay, the ground will be highly benefited. Plenty of stable manure, especially rotted in a compost pile, can be used in place of cowpeas. If not well decomposed, the manure should be applied in the previous fall, preferably, harrowed or disked in after

plowing. Commercial fertilizers may be used in the spring in addition to these manures. Very soluble nitrogenous fertilizers should be applied as directed under the heading "Commercial Fertilizers" (page 7). Potash and phosphatic fertilizers should be applied before planting, as already explained.

The very numerous experiments carried on by the various experiment stations with commercial fertilizers on potatoes have not established reliable formulas as to the amounts or ingredients, which will vary with the characters of each soil. To quote from the Bureau of Soils, Bulletin No. 65, entitled, "Fertilizers for Potato Soils," by Milton Whitney: "It appears from published records that in 23 States the experiment stations have made 1769 tests of substances applied to all sorts of soils. The variation of yield on unfertilized check plats in the same field, and the variation of the increase attributable to fertilizers on different soils and in different seasons, are large. Nevertheless it appears:

"1. The chances to obtain an increase in the crop and the actual increase in bushels are larger with two or three substances mixed than with a single substance.

"2. There is little indication of any significant difference in productivity due to different amounts of fertilizers used.

"3. There is little indication of any significant difference in effectiveness of fertilizers on soils of different natural productivity, as measured by the yield of check plats, such differences as are shown indicating a somewhat greater efficiency of some fertilizers on more productive soils."

In general, most lands will give profitable increase in the yield by applying 200 to 500 pounds of cotton seed meal, or the equivalent in other nitrogenous fertilizers; the same weight of super-phosphate and 100 to 150 pounds of sulphate of potash. This would give of actual plant food per acre about the following amounts: Nitrogen, 16 to 47 pounds; phosphate, 37 pounds; and potash, 52 to 78 pounds. The application of the mixed fertilizers, acid phosphate and potash, should be made a few days to a week before planting, especially if the application is large. The best way is to lay off the rows with a large shovel, or small, solid sweep, distribute the fertilizer in the bottom of each furrow, after which it should be stirred into the soil by running a bull-tongue, or narrow shovel, along the bottom. If cotton seed meal, tankage, or any other easily fermentable nitrogenous fertilizer is to be used, one part of it, say one-half or one-third, should be applied with the mineral manure. After the distribution of the fertilizers, the furrow should be filled with a plow, so that the earth forms a small ridge over the fertilizers. At planting the furrow is reopened along the ridge and reclosed after planting; unless a planting machine be employed which will do its own opening and closing. The remainder of the dose of organic nitrogenous manure is applied when the young plants have set a few leaves, or reached the height of two to three inches.

The proper distance of planting is 30 to 36 inches between the rows and 16 to 18 inches apart within the row. It is well to plant the potato cuttings three to three and one-half inches deep, leaving a slight ridge over the cuttings in covering. This extra amount of earth may serve as a protection to the cuttings, both against excessive cold and excessive moisture, and can be harrowed off as growth sets in.

Seed potatoes should be of good size and free from blemish of any kind. If the surface of the potatoes shows sign of scurfiness, due to scab, which is a frequent disease in moist, heavy land, and readily transmitted to the new crop, they should be disinfected. This can be done by soaking them for an hour and a half in a solution of corrosive sublimate, using one ounce of the poison to eight or nine gallons of water. This is preferably done before cutting, although it may be done after cutting. The cuttings should be made of ample size, but one good, strong eye is all that is necessary to make a new plant, if this eye is situated on a good sized, plump piece. On a medium sized potato all the flesh should be divided between cuttings, so as to furnish abundance of food materials for the growth of the new sprout. Cultivation should be frequent during the growth of the vine, and as soon as possible after rains. The smoothing harrow, or even better, the weeder, is the best tool for stirring the surface before the plants have come up. This is especially beneficial, since it will conserve the moisture, produce a freer circulation of air in the soil, so necessary at the time of sprouting; and finally increase the absorption by the soil of the sun's heat, and make it more retentive of this heat during clear and cool nights.

The length of the season in Texas permits of raising two crops of Irish potatoes; a spring crop that may be planted from the beginning of February to the middle part of March, and a fall crop that may be planted from the latter part of August to the latter part of September, all according to the latitude and moisture conditions of the locality. These two crops have long been raised in the Atlantic States and to some extent in East Texas, where moisture is more liable to be present during the fall months. The spring crop is, of course, the market crop. The fall crop has been smaller, both in area and in yield, but of great value, inasmuch as it has furnished seed potatoes for the spring crop. In fact, it is generally agreed to by all who have grown their own seed potatoes, that the yield from them is from eight to ten per cent larger than from the imported seed. The fall crop may also be grown from home made seed of the spring crop, including the tubers, too small for market purposes. The trouble with the home grown seed has been to secure quick and regular germination. This has especially been difficult for the fall seed, where many immature culls have been used for seed purposes. The practice of later years has shown that the best method of treating potatoes intended for fall planting is to spread them out in a thin layer under a shed, or under any screen, especially where the temperature is as low as possible, but to allow enough diffused light to give them a decidedly greenish color. They must not at any time be exposed to the heat of the direct sun. Professor Massey in Bulletin No. 85, of the North Carolina Station, recommends bedding to force the buds after "greening." The bedding is done as in the case of bedding sweet potatoes for slips, with this exception, however, that no heating or composting materials be used, only ordinary sandy loam, or even sand. Such a bed should be located under shelter from direct sunlight and too high temperature. Sprinkling must be moderate, so that the soil is kept merely in a moist condition, not to such a degree as to be called wet at any time. In this bed the potatoes are to remain until planting time. By that time the eyes of all that are good will show

indication of sprouting. Those in which the eyes show no change, may be discarded as worthless for seed. General experience has shown that seed potatoes should be planted whole for the fall crop.

The question has arisen as to whether the Irish potato degenerates when raised continuously from southern grown seed. To this can be answered that this degeneration may be more due to the successive use of culls than to the successive use of southern grown seed.

The question as to how often it will be necessary to return to northern seed is yet an open one, although several generations have been grown from southern seed without depreciation of the crop. Much depends on the nature of the soil, the abundance of plant food, and the care in selecting the seed. Continual use of culls for seed in connection with low fertility of the soil will undoubtedly reduce the vitality of the crop, while the opposite conditions will maintain, and, to some extent at least, invigorate the vitality.

Professor Massey recommends, in the bulletin just mentioned, that the late crop be planted deeply on flat ground, but shallowly covered, and that the earth be worked to the vines as they grow. It is also necessary to carefully rotate potato crops, as the diseases to which the potato is liable remain in the land after the removal of the crops and are ready to attack the succeeding crop with increased vigor; for example, in the case of scab and dry-rot. Of other diseases to which the Irish potato is liable, the early and late blight may be mentioned. The late blight, *Phytophera infestans*, is especially destructive in northern countries. It has at sundry times produced complete destruction of the potato crop of an entire country, as in Ireland in 1845. It is, however, mostly confined to the northern potato growing section. The late blight is, however, more to be dreaded in the South, especially since it attacks other members of the same family of plants, such as the tomato and even the Jimson weed. Both of these blights may be held in check, or entirely prevented, by early spraying with Bordeaux Mixture, made up of 5 pounds lime and 5 pounds of bluestone to 50 gallons of water.

The varieties of Irish potato best suited to our Texas condition, both for spring and fall planting, are, as in the case of most other vegetables, the very early ones. The following are varieties well recommended by the experiment stations in the South: Early Rose, Peerless, Triumph, and Beauty of Hebron. Of these the Triumph is widely cultivated in Texas and much esteemed for its good qualities and general hardiness.

*Tomato, Pepper and the Egg-plant.*—As in the case of the Irish potato, these are also natives of South America, and were first brought into notice by the Spaniards in the Sixteenth Century. *Capsicum*, the pepper, occurs in cultivation in numerous forms attributable to three species; namely, *Capsicum annum*, from which we have the large sweet peppers, such as Bell, Sweet Mountain, Golden Queen, and Ruby King. From *Capsicum longum* we have the Tobasco, Coral Gem, and Chili pepper. These latter produce small pointed pods, in which the meat is hot and pungent, as well as the seed. Finally, we have the *Capsicum baccatun*, which occurs native as far north as the southern border of Texas. The principal varieties of this are the Cayenne and Cherry peppers. These are also, as the last named, hot peppers.

The tomato, *Licopersicum esculentum*, is also a very variable plant

that has undergone in cultivation great changes in size, form of the fruit and relative quantity, and quality of meat. The varieties in cultivation a generation ago produced much smaller fruits of an irregular or lobed cross-section, such as now are counted as culls. Dwarf and erect growing forms have become common. New varieties with enormous fruits, too large for easy shipping, are multiplying with each year. There is scarcely a plant in cultivation that in so short a time has undergone such evolution. Besides the increase in size of fruit, we have also obtained decrease in the size of the fruit and increase in size of the clusters; such as Red Cherry, Yellow Cherry, and pear shaped types of the same size, but varying in color and numbers of fruits to the clusters. Each kind has its special uses.

Some of the varieties that are most popularly raised in Texas for the northern market are: Acme, Livingston's Beauty, Livingston's Stone, Earliana. These are all of medium size and of a regular, rounded form, and a brilliant pink to deep red color, when fully ripe. Of large size and equally good quality we have the Ponderosa, Crimson Cushion, and others. The dwarf Champion produces fruit of medium size, but of great beauty and good quality. This is also much raised, especially on account of its erect and compact habit of growth.

Tomatoes, egg-plants and peppers require the same soil and the same climatic conditions. The soil is the same as for Irish potatoes, but less nitrogenous fertilizer is necessary. This is especially so for the tomato; since a fertilizer rich in nitrogen produces too much vegetative growth, which may become detrimental to fruiting, and even be one of the causes of the shedding of the flowers, or young fruits.

In central Texas the seed for these vegetables should be sown in hotbeds during the middle of February and cared for as described under the topics of "Forcing Frames," "The Hotbed" and "Transplanting" (page 15). Tomato plants should be given a distance between the rows of 3 to 3½ feet and 18 to 20 inches apart in the row. While the vines are yet erect and self-supporting they should be staked and tied to the stake. At the same time, all lateral shoots should be pinched off as soon as they start, allowing only the terminal growth. When three to four clusters of fruits are set, the terminal shoot is cut off one joint beyond the uppermost cluster. This is the method now in vogue by all who grow tomatoes on a commercial scale. It has the effect of producing fruits of great beauty and uniformity; this also keeps them less liable to premature dropping, which occurs more freely when the vines are allowed to grow unpruned and unstaked. The shedding of the young fruits, or the flowers just before setting fruit, may, however, be due to several causes; such as too rank growth of shoots, excessive heat and lack of moisture in the soil. Another common cause of loss of the fruit is the dry-rot disease, attacking the young, green fruit, starting as a black, rotten spot at the flower end. This trouble is of bacterial origin, but is much lessened by frequent spraying with Bordeaux Mixture during the season of fastest growth.

The above recommended pruning of the tomatoes has, naturally, the effect of shortening the life of the vines. For home market or home consumption, the fruiting season is to be prolonged, either by successive

plantings or by pruning less severely, especially when training to trellises instead of stakes.

Tomatoes can also be grown as fall crop in Texas, where sufficient moisture is available at that season. Fall sowing should be made in well sheltered cold frames, so that the plants will become large enough for transplanting into open field in September.

Peppers and egg-plants need, as already stated, the same cultivation and general care, except that they are not subject to pruning and staking. Both of these will continue to bear until late in the fall, if moisture is present and proper cultivation be kept up.

The egg-plant is especially subject to ravages of biting and leaf-eating insects, among which is the common potato beetle. The safest remedy against insects of that kind is the powdered Arsenate of Lead, applied with a powder bellows, while the dew is on the plants.

### THE PEA FAMILY—PEAS AND BEANS.

This family of plants, though important because of its garden plants, is much more so because of its general and unique value to agriculture as a whole. First, from this family we have the greatest number of our richest forage plants; second, the species of this family have the monopoly among higher plants of taking nitrogen from the atmosphere and incorporating it into their own substance. Hence, they are the only plants, which will when used as green manure, furnish to the land valuable plant food that they did not, in the first place, take from the land.

In this country three classes of vegetables from this family are common in our gardens; namely, the English pea, *Pisum sativum* of the botanists; the kidney bean, *Phaseolus vulgaris*, and the lima bean, *Phaseolus lunatus*.

In southern Europe, besides the above mentioned, other plants furnish similar vegetables, such as certain species of vetch, *Cicer* or chick pea, and the Lentil.

The Kidney Bean, or Snap Bean is a native of South America, and when brought to Europe in the Sixteenth Century, soon displaced the beans (Dolichos of East India origin) in cultivation up to that time. The cultivation of the garden pea goes back to prehistoric times; and, as it is nowhere found wild, its original home is unknown. Some botanists presume that it has arisen in cultivation from the field pea, *Pisum arvense*, which grows wild in mountain regions of southern Europe.

The requirements upon the soil are the same for each of these three classes; namely, a light open sandy loam, well drained, and rich in vegetable matter, so as to be able to retain moisture well. Applications of nitrogenous fertilizers on such lands are not necessary, but phosphates and potassium salts will, on most lands, be beneficial. It must be added, however, that none of the plants form nitrogen nodules with the ease and in the abundance with which they are formed upon the roots of the cowpeas and the peanut, in all classes of Texas soils.

As to the habit of growth, each class may be divided into climbers and dwarfs, or bush forms; of which the dwarfs reach maturity and run

their course in a shorter time. The beans prefer a hot climate, while the peas prefer a cool climate and are among the vegtables that can stand a considerable degree of frost. All three classes can be raised throughout Texas, wherever the proper moisture can be had, both as spring and fall crops. For the latter season the earlier bush forms are the safest.

English peas can be planted during February for spring crop; early in September for fall crop. In the southern Gulf coast country and along the lower Rio Grande, they can be grown continuously from fall throughout winter and spring months. In Rusk county, east Texas, I have seen the Champion of England planted in the early part of January and survive the winter, with unimpaired vigor, in situations without any special protection. The plants were cut back during the more severe freezes but returned to new growth immediately upon the return of milder weather.

The heaviest and most persistent yielders are the tall varieties of the pea. Of these I know of no better variety than the Champion of England, because of its abundance of large, well filled pods. Its productiveness is only cut short in late spring, when it generally becomes attacked by mildew. The dwarf varieties are not so much subject to mildew, can stand warmer weather, but are soon exhausted after a few pickings. There are also medium tall varieties, but these in order to do well must be staked, as in the case of the tall. The best material for stakes are straight bushes, 5 to 6 feet tall, with a few branches for the plants to catch hold of. Where proper materials for such stakes may be scarce, light poultry wire-netting may be stretched as a temporary fence along each row after planting. This netting, to serve the best purpose, should be 3 to 4 feet wide and fastened to the posts 1 to 1½ feet above the ground, so as to easily admit of weeding.

Both peas and bush beans are planted in drills 2½ to 3 feet apart. The amount of seed necessary to plant an acre varies from 1 to 1½ bushels, according to size of seed. The best distance between plants in the drill is from 4 to 6 inches, according to size of plants. In the case of pole beans a distance of 2 to 2½ feet should be given between each hill in the row. Tall peas are generally planted at the same distance apart in the row as the dwarfs. In selecting varieties, when these are not already known, it is always the safest policy to secure a descriptive catalog from reliable seed houses. The size of the plants and the length of time from sowing to maturity is very important knowledge to the planter, and generally correctly stated in the catalogs.

The number of varieties under each class of both beans and peas, especially of dwarf to medium forms, are confusingly great. Among the peas, we also have varieties with edible pods, which are succulent and of pleasant sweet flavor. These are generally described as Sweet or Sugar peas in the seed catalogs.

The most common disease on garden peas is the white or powdery mildew. It is not prevalent until the weather becomes warm in the late spring, or early summer; and, as before stated, some of the tall forms are more susceptible to it. Beans are subject to the same disease, but to a lesser degree. The remedies recommended as preventives and

check of the disease are dusting the plant with flowers of sulphur or spraying with Bordeaux Mixture.

### THE MORNING GLORY FAMILY—THE SWEET POTATO.

The only plant for our vegetable garden that this family has furnished is the sweet potato; a true morning glory, being a species of that genus, and called *Ipomaea batatas* by the botanists. Its original home has been stated to be East India, but later and closer researches into plant geography have placed its origin in South America. According to Dr. Ludwig Reinhardt, the more definite region of its nativity is Brazil, because there several species closely related to our cultivated forms are found wild. The sweet potato was, according to the same author, cultivated by the Indians throughout all tropical America before the advent of the Europeans. The sweet potato, as in the case of many other American products, was introduced into Spain in the Sixteenth Century, whence its culture spread into the Mediterranean countries, both in Europe and Africa, and soon reached the East Indies and China. It is said to have been known in England even before the Irish potato was known.

The sweet potato has given rise to numerous varieties, more or less distinct from each other in quality, size, form of tubers, as well as in foliage and vine. But the peculiarity is that the greater number of these varieties have arisen by bud variation in countries where the sweet potato seldom flowers, and where seed is out of the question. New varieties seem constantly to come into existence in this manner. Two races quite distinct as to quality may be recognized; namely, the Jersey Sweet, which are dry and mealy and preferred in the northern market; and the Yams, or those of a sappy consistency, that exude a syrupy liquid when baked, are those of high favor in the South. As to forms of tubers and forms of vine and foliage, the varieties cannot be distinguished with precision, because in these respects many of them grade into each other, so that no sharp line of demarkation can be decided on. This is also natural, when their origin from bud variation is considered. For example, in the case of the Vineless there are two forms, one with small leaves and quite slender vines, and another very robust, with leaves similar in form but much larger, and the vine much stouter. Both of these forms, especially the slender, have a strong tendency to "sport" back to the long, running vine. With the slender form it is my observation that this returning to long vine is accompanied with deterioration in size of the tubers, and with a tendency to flower. Selection in the field of tubers for propagation, is, therefore, best, but not an absolute remedy against loss of the type. The proclivity to bud variation is evidently the cause of the belief among many farmers that different varieties of sweet potatoes will "mix" if planted in close proximity to each other.

Sweet potato is more frugal as regards soil fertility than the Irish potato, but generally fastidious as to soil texture. A sandy loam of good depth, well stocked with humus, and underlaid by a clay of moderate porosity, or good sub-drainage, is the best. On such soil the tubers become smoother and more uniform both in form and in size. The best crop

to precede sweet potato, as in the case of Irish potato, is a crop of cowpeas, preferably applied as green manure the previous fall. Good loamy land so treated and planted with a prolific variety ought to produce a crop of 200 bushels of marketable potatoes per acre, without any other fertilizer.

It is not common among the farmers to select sweet potatoes for propagating purposes; tubers too small for market purposes, and even stringy and deformed ones are frequently used. There is good reason to doubt the soundness of this practice, as it may be noticed during the digging that deformed, stringy tubers are often the products of plants that have deteriorated from the type as "sports." Whether the size of the tubers used for seed effects the progeny is yet unsettled; but too small tubers are frequently immature, and thus liable to rot in the bed and cause general infection. Tubers perfectly sound, without cuts or bruises, well formed and of fair size, are undoubtedly best for seed purposes.

The bed for raising the "slips" should be located in a spot with good drainage, and where shelter against cold or excessive rains may be afforded, as under the cover of a frame. The most common method of making the bed is to place a layer of slowly heating manure in the bottom, then a layer of 4 to 6 inches of good mellow garden soil, and on the top of this the potatoes, being careful not to let them touch each other, thus preventing a rapid spread of rotting, in case any tubers should become infected. The layer of potatoes is then covered with 3 to 4 inches of good mellow dirt. The time for this work in Central Texas is from the middle to the latter part of February. Nothing is gained in the northern half of the State by planting before the first of May. Slips planted out as late as the first of June frequently make as good a crop as those planted before the first of May.

The common way is to plant in rows or beds slightly raised, and 3 to 3½ feet apart. A suitable distance between the plants in the row is about 20 inches. Cuttings, 12 to 16 inches long, taken from vines already growing will do as well for propagation as slips drawn from the tubers. Preparatory to planting, it is well to heal-in such cuttings for a few days, in a trench, where they can be sheltered and watered. They will, in that case, start roots quickly, and can be planted out with much greater safety. It is a good precaution to handle both the slips and the cuttings so that no wilting takes place before or during the planting. The proper depth of planting is 4 to 5 inches, leaving about two joints out of the ground. The earth should be well firmed around the slips or the cuttings, as this will promote easy absorption of soil moisture. Cultivation should be given immediately after planting, to leave a good dust mulch and obliterate the tracks made during planting, since if these be left, they become so many leakages of soil moisture through evaporation.

Sweet potatoes need thorough and constant cultivation, not only to keep down weeds, but to conserve moisture, and also to keep the soil well open to air, which is of special importance to all root crops.

Sweet potatoes are "easy" on the land and easily grown, but quite difficult to keep after harvesting. Bruising in handling is sure to produce decay. Digging and storing before maturity is another fertile source of decay. If a tuber be broken across, and the surface, due to the

break, shows no exudation of liquid, but dries and crusts over quickly, the tuber may be considered matured.

Specially constructed storage houses are recommended for extensive growers of the sweet potato.* It is an excellent precaution to fumigate the house by burning sulphur in it before taken into use each fall; and, indeed, it is possible that a moderate amount of such fumigation can be done after the sweet potatoes are put in the bins. A reliable farmer in this neighborhood informs me, that for several years he has had excellent success in keeping his sweet potatoes in an ordinary dug-out cellar by fumigating with sulphur after having stored them. Before beginning this practice, his potatoes were frequently lost through rotting. He states that he was induced to start this practice in order to drive away rats, which had infested his cellar. The potatoes kept unusually well after the fumigation, nor were they injured for seed purposes. As a consequence, he fumigates his crop every year, with marked success in keeping.

Personally, I have no experience with the effect of sulphur fumes on sweet potatoes, but consider the method reasonable and worthy of trial.

Sweet potatoes are not only a valuable food for man, but equally as valuable and cheap food for animals. Cows relish them, and the increase in the flow of milk is marked. For feeding cows they should be chipped up and sprinkled with cotton seed meal or bran. Hogs when turned into a field will do their own harvesting, without wasting a single tuber. If a patch of late maturing peas, such as the Unknown, or Wonderful, be planted alongside of the sweet potatoes, the hogs will help themselves to an economic and effective ration. The two late crops, cowpeas and sweet potatoes, may be rotated one with another, and be planted after an early truck crop has previously been removed from the same land during the same season.

*Varieties.*—The varieties of the sweet potato are very numerous, but the names seem to be hopelessly confused; since many of them, especially the southern kinds, are local and not general; hence, known by different names in different localities. Nor are they easily recognized from description, as the differences in form and color of the leaves, vines, and roots are very slight and vary on different soils and in different localities. One of the best defined, both as to the vine and foliage, is the Vineless, sometimes called the Bunch Yam, so-called, perhaps, because its vines form dense, compact bunches. It is an excellent variety, easily cultivated, very productive, early and of good quality. Another, easily known, because of its long, dark-green to slightly purplish vines, with heart-shaped, entire leaves, and elongated yellow meated tubers, is the Pumpkin Yam. This is very popular in the South especially when baked, as it is very juicy or syrupy. "Choker," or "Nigger Choker," is very prolific on any soil, produces very large, coarse, veiny tubers, of inferior quality for cooking purposes, but excellent for hogs and cattle. Other varieties popular in the South are: Southern Queen, Nancy Hall, Brazilian, and Yellow Yam.

*Farmers' Bulletins Nos. 520 and 548, United States Department of Agriculture, Washington, D. C.

## THE CUCUMBER FAMILY—CUCUMBERS AND MELONS.

Under this family, we have in cultivation the following classes of plants: Cucumber, Muskmelon or Cantaloupe, Watermelon, Squash, and Pumpkin. Each of these occurs in numerous varieties. All of them are similar in habit of growth and in their demands on soil and climate. Most of them have come to us from Western and Central Asia. All are annuals, and cannot stand the slightest touch of frost. They prefer a warm, sunny climate and soil of sandy loam, well supplied with humus, and retentive of moisture. The best preparation of the land is to precede the crop of these plants with a crop of cowpeas turned under as green manure during the previous fall. Land so treated, if liable to washing, should not be left exposed to the winter rains, but be sown to oats, or other winter grains. This may be pastured until time for spring plowing.

The best fertilizer for melon vines, whether the land has received a crop of green manure or not, is a compost of well rotted stable manure, applied directly in the hills and worked into the soil. If ground rock phosphate and kainit has been added to the compost, so much the better. If no stable manure or compost can be had for direct application to the hills, commercial fertilizer may be of advantage. Circular No. 9, on "Muskmelon Growing," of the Arkansas Experiment Station, makes on this subject the following recommendation: "As general application in the way of commercial fertilizer to be worked into the soil in preparing the land at the time of planting, apply 1000 pounds of a fertilizer of the following formula:

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|---|---|
| Nitrogen | 3 to 4 per cent. |
| Phosphoric acid | 8 per cent. |
| Potassium | 10 per cent. |

For nitrogen the author recommends organic forms, such as cotton seed meal, ground tankage, or dried blood.

After the land has been broken in the spring, it should be marked off for the hills, which is most cheaply done by making check furrows with a shovel-plow. The distance varies with the nature of the plants. For muskmelons and cucumbers, 5 to 6 feet, and for watermelons and pumpkins, 7 to 8 feet apart. The squashes, being more bushy in habit of growth, need only to be planted 3 by 4, or 4 by 4; feet apart. The manure should be worked well into the soil at the crossings of the furrows, where the hills are to be located. As many of the seeds in both cucumbers and melons are frequently faulty, from 8 to 12 seeds should be planted in each hill to insure a perfect stand. When germination has taken place and the stronger plants are distinguishable, three or four of these should be left in each hill—the others pulled out. It is also well at the same time to draw a little more earth around those left in the hills, as this has a tendency to strengthen and prevent them from being broken by wind or rain.

Melon vines may also be forced; that is, the seed may be planted in hot frames about a month before the time for planting in the open ground. The best way of doing this is to secure materials for straw-

berry boxes, or strawberry boxes knocked down, and in putting them together leave out the bottom; fill them with good mellow dirt and plant the seed in them. These boxes can be easily handled without bottoms by well firming the dirt put in them, and by lifting and moving them by means of a mason's trowel, or similar instrument. Besides these, pasteboard boxes of suitable size will answer the same purpose. The bottoms of these need not be removed, as the pasteboard, after having been in contact with the soil and moisture, will offer no resistance to the roots. After planting the seed, the boxes should be placed in the hot bed, where the young plants are to be given proper watering, shelter and light. The temperature should not be over 80 degrees, nor less than 55 degrees Fahrenheit. But as the plants grow the light may be increased to harden them, preparatory to transplanting into open ground. Transplanting should be done without any disturbance to the roots; simply by removing the boxes carefully to the field, and sinking each to a proper depth in its prepared hill and firming the dirt around it.

Cultivation must be constant and clean to conserve moisture and to prevent the start of crab grass, which is so liable to infest sandy soil. A strong remedy against the crab grass is a dense crop of cowpeas during the previous summer. It is proper here to add to the afore-mentioned virtues of the cowpea that it is also an excellent weed exterminator, if given proper cultivation when young. For this reason, it is common practice, at the last cultivation of the melon vines, to sow cowpeas broadcast in the middles between the rows, they hold down the crab grass and other weeds and shelter the melon vines and fruit from too strong sun and wind. Such shelter is most beneficial; and a watermelon covered from the direct sun, is generally increased in size and improved in quality. The only drawback resulting may be in dry seasons, when the peas take up more water than can be spared from the melons.

Excess of growth on the part of the vines, both in cucumbers and melons, is sometimes accompanied by corresponding lack of fruiting. The remedy is pinching off the terminal buds of the main branches, so as to stop lengthening and force the sap to act more on the lateral branches. The size of the melons can be increased my reducing the number per branch, by pinching the youngest fruits off, as soon as the number of fruits desired is set. This amputation is effected at the second or third joint beyond the last fruit. This can be practiced to good advantage with the watermelon, where more than two fruits per branch results in the reduction of size on the part of the younger. In the cantaloupe, where the number is less liable to affect the size of the fruit, this pinching is not necessary.

Since both the quality and the size of all melons, as well as cucumbers, are much hindered by excessive heat, it is an advantage to secure earliness by starting them in hot beds.

Watermelon seed should be obtained in the South, preferably at home, where the largest fruits and most typical in form and quality should be selected for this purpose. Care must be taken, if purity is wanted, not to select where several varieties are grown in close proximity, as their progeny is almost certain to be mixed. The same is true for all plants of the cucumber family.

Varieties of watermelons are numerous; some that were popular a few

years ago are now not even in seedsmen's catalogues. At present the following are popular, both for home and export: Tom Watson, Alabama Sweet, Georgia Rattle Snake, Bradford, and others of more local reputation.

Cantaloupe or muskmelon seed are generally obtained from localities in the North having acquired reputation for fruits of high qualities, such as Rockyford, in Colorado. Cantaloupes, when continuously grown in the South, seem to increase in size and correspondingly decrease in flavor. It is, however, very likely that the Trans-Pecos country, and other high and dry localities, which are producing these fruits to as great perfection, may be as well adapted for the production of the seed as Rockyford in Colorado.

The most popular varieties of the muskmelon are the cantaloupes, or those of a depressed spherical form, with closely netted corky lines on the rind. They are of small size and greenish to yellowish colored flesh, the flavor of which is a melting, spicy sweet. A great number of varieties of these occur both in southern Europe and in this country. Among those that are especially popular in this country may be mentioned: the Rockyford, Netted Gem, Nutmeg, and Jennie Lind.

To the muskmelons belong also the winter melons, which are, up to the present, little cultivated in this country. They are of oval form, mostly with smooth white to greenish rind, but white meat, which does not develop its full flavor until the melons have been kept in storage for some considerable time; hence the name "Winter Melon." They are, however, much inferior to the true cantaloupes.

The larger number of the cucumbers are raised for pickles, either whole or to be cut up and mixed with several other vegetables in chow-chows, which are both popular and highly spiced dishes. Cucumbers intended for this purpose are generally harvested as soon as they have reached the size of 4 to 6 inches in length. The most popular varieties are: Early White Spine, Cool and Crisp, Everbearing, and Early Frame.

Cucumbers may be easily kept for any length of time in strong brine of common salt. When ready for pickling, the salt may be withdrawn by soaking in pure water.

There can be no doubt but that pickle factories, which use so many kinds of our most perishable garden vegetables, would form a most profitable and helpful industry in sections where these vegetables are now raised in abundance at an almost prohibitive distance from the market, as, for example, in the lower Rio Grande Valley and the Gulf coast.

The pumpkins, besides furnishing excellent material for pies, are also raised extensively in the Northern States as a choice feed for dairy cows; nor is it the only member of the family that is of value for this purpose, as all the fruits of the whole cucumber family, with the exception of the gourds, are high-class foods for the milk cow.

### LAMBSQUARTER, OR CHENOPODIUM FAMILY.

From this we have the beet (*Beta vulgaris*) and spinach. The beet is native of the same regions as the cabbage; namely, the Mediterranean and the Atlantic coasts of Spain and France. The spinach is supposed to have come to us from Asia. Both of these plants are quite resist-

ant to frost and grow well during the milder part of our winter. In fact, the soil, climate and cultivation are the same as for turnips. Like the turnips, the beet can be raised both as a fall and as a spring crop, but differs from the turnip in that it remains succulent for a longer time and does not become hard and pithy as early in its development.

*Beets.*—Three classes of the beet have been obtained by selecting seed for three different purposes; namely, the garden beets, the sugar beet, and the mangel-wurtzel. The latter is a large, coarse beet, occurring in numerous forms from long, slender, crooked cow-horn form to globe-shaped. This beet is becoming popular as a cattle food, especially during the season when succulent fodder is scarce. The yield from unmanured land, according to Cornell Station Bulletin No. 267, ranges from 14 to 18 tons per acre. In Texas these beets do not require storing, but may be left in the field to be harvested as needed for use.

The sugar beet is cultivated in the cool, temperate climates, both in this country and in Europe. In the Southern States, and all other places with very hot summers, the sugar content becomes too low for remunerative cultivation.

To sow one one acre of beets in drill requires 5 to 6 pounds of seed. Fall sowing of garden beets can be done in early September, and spring sowing may be done as soon as the temperature is safe for corn planting. So soon as the young plants have made three or four leaves, they should be thinned to from four to six inches apart in the drill.

Garden beets, remaining in the field long enough to deteriorate in table quality, make excellent cow feed. They will not fail to increase the flow of milk, when cut up and fed with cotton seed meal or other concentrated feed stuffs.

The most popular varieties of garden beets are: Egyptian Turnip, Eclipse, Early Blood Turnip, and Bassano. These are all more or less globular in form, of good size and with red to dark red meat, except Bassano, the meat of which is streaked with white or pink color.

*Spinach.*—Spinach can be raised over the larger portion of Texas from fall until the temperature becomes too high in the spring. Its cultivation is the same as that of kale or mustard. Spinach is a salad plant. The leaves are cut for harvest as soon as they reach the proper size, after which the plant continues to grow new crops.

### CARROT FAMILY, OR THE UMBELLIFERAE.

From this family we have the following cultivated as garden vegetables: Carrot, Parsnip, Celery, Celeriac, and Parsley.

Most of the members of this family develop essential oils and gum-resins which may be formed in all parts of their organs; hence, for culinary purposes they are especially used for the delicate flavors that they impart. In the carrot and parsnip we have also most wholesome food in addition to the flavor.

*Carrots and Parsnip.*—Carrots and parsnip, natives of Europe, are naturalized in America. Even in Texas the wild parsnip is not an uncommon weed. Wild carrot is especially a common weed in meadows of the Northern States. The wild forms, however, are annuals, with a hard, woody, tapering tap-root, but the parts above the ground differ neither in form, color or aroma from that of the cultivated varieties.

Both carrot and parsnip are resistant to frost, especially the parsnip, which can pass the winter uninjured in countries where the frost goes deeply into the ground. For this reason, crops can be raised from both fall-sown and spring-sown seed. Mellow garden loam, well enriched by manure, especially humus-forming manure, is preferred by both. The parsnip will do better on heavier soil than the carrot. The proper time for fall sowing is in September. The seed of both carrot and parsnip is somewhat slow of germination; besides, only about 60 to 70 per cent can be expected to germinate; hence, as much as 4 to 5 pounds may be needed of each kind of seed to sow an acre in drills 2½ to 3 feet apart. The proper depth at which to sow the seed is from ½ to ¾ of an inch. In about eighteen days the seed will germinate. As soon as the young plants grow sufficiently to produce several adult leaves, they should be thinned to a distance of 6 to 8 inches apart in the drill. Both classes are heavy yielders in good and well cultivated soil: carrots, 400 to 700, and parsnip, 500 to 800 bushels per acre. (Horticulturists' Rule-Book, Bailey.) The proper time for early spring planting in any given locality would be about the same as for early corn planting.

The varieties of carrots are quite numerous, and are roughly divided according to the length of their roots into long, half-long, and short. They are also distinguished by the color of the roots, into white, orange and red; as, for example, Long Orange, Belgian, or Long White Belgian, and the Early Half-Long—a variety of excellent flavor and about 6 inches long. The Ox-Heart is a short rooted variety, about 4 to 5 inches long and about 3 inches in diameter.

The parsnip is not cultivated in as many varieties as the carrot, nor to such an extent, although it contains more nutritive matter. Both the carrot and the parsnip are greedily eaten by all our domestic animals; horses are especially fond of carrots, while dairy cows fed on parsnip are said to give butter of improved quality.

The two main varieties of parsnip are the Hollow Crown and the Guernsey. Among the various ways in which the carrot and the parsnip can be utilized are as ingredients of meat soups. For this purpose no other vegetables can fill their place. Tomato is often used, but the soup is lacking in quality.

*Celery and Celeriac.*—Both of these originated from the same wild species called *Apium graveolens*, growing wild along the Mediterranean coast, and frequently within reach of the sea spray. For this reason, the cultivated celery is one of the few plants that can thrive in soil of considerable saltiness or alkalinity.

Celeriac develops a large, rounded, fleshy root, which is the only part used, either for flavoring meat soups, or in salads. In Europe this plant is cultivated to considerable extent; in America, on the other hand, only in the vicinity of the large Northern cities. The seed is sown in the North in hot-frames, or in "flats" placed in hot-frames during January or February; replanted for larger space and hardening as soon as large enough, then transplanted into the open ground, where it forms roots large enough for use by next fall.

In Texas, both forms are best suited for fall and winter vegetables, owing to the fact that our temperature is too high to produce tender tissues and delicate flavors during the summer. The plants can stand

a slight frost, but not to the extent of hard frozen ground; hence, the most proper climate in Texas is the Coast country and the lower Rio Grande Valley. If the crop of celery is far enough advanced to be well earthed up for blanching, it is in condition to stand several degrees of frost; therefore, the earlier the crop can be started, and the faster it can be made to grow, the more liable it is to escape destruction or injury from frost.

The proper time for sowing celery seed in Texas is during August and September, according to latitude; for it must be remembered that the seed is slow in germinating, even if quite fresh. Seed more than a year old may fail to germinate altogether. The best method is to sow the seed broadcast on the surface of good, mellow and moist soil placed in shallow boxes, then cover them with a layer $\frac{1}{4}$ to $\frac{1}{3}$ of an inch thick of more earth, after which the earth should be firmed by pressing it with a piece of plank or any suitable instrument. A very thin layer of fine sharp sand on the top will do good. A layer of mulch of gray moss or other similar material is necessary to prevent excessive evaporation. This mulch should be removed upon germination of the plants. The boxes should be placed in a cold-frame covered with a roof of lattice-work, so made as to exclude one-half of the direct sunlight, and high enough above the bed to admit of a person working underneath. Such frame ought also to be situated in a place sheltered from the wind. Protection from heavy, beating rains may be had by spreading oil-cloth covers over the top of the lattice roof.

As soon as the young plants have set several leaves, these should be shortened back with sheep shears or some such instrument. This will greatly help to stouten and harden the plants. Sprinkling sufficiently to keep the soil moist at all times should be provided, preferably during morning and evening, or during the cool of the day. As soon as the plants are strong enough, and before being weakened by crowding, they should be transplanted from the seedling trays, or seedling rows, into new frames, and there given more space, four by six inches apart will be sufficient. In doing this transplanting, it is a good precaution to again clip the leaves back to about half their length, and water the soil in which they stand before transplanting. As the transplanting proceeds, moderate watering, and if hot and dry weather, also shading should follow. As previously mentioned under the general discussion of starting tender plants, potting the individual plants at this stage is the most advantageous method.

As soon after this transplanting as the plants have grown stout and hardy enough, they are ready for the second transplanting, or into the open field. This last transplanting is to be done with the same care as the first. The soil or pots, if they be potted, should be sprinkled, and the water given time to soak in before the plants are removed. The plants should be carefully lifted out of the bed with trowels, so as to do as little injury to the roots as possible, and leave as much dirt on them as possible. It is also a good precaution, if the dirt fails to stick to the roots properly, to puddle the roots in a soup of clay; because, thus coated, they immediately adhere to the dirt into which they are transplanted. The plants should be brought to the field carefully packed in trays or boxes with the roots at the bottom and the foliage, if the weather be hot and dry, covered with moist cloth as a protection

against wilting. For it must be remembered that any wilting at this stage may retard the growth for a long time. In planting, the soil must be well pressed against the roots and these placed at the same depth that they had before removal. These precautions hold good in all transplantings.

For their best growth celery and celeriac need a deep, fairly compact soil, rich in humus and moisture. In Michigan and other places, where their culture has become a specialty, tile drained marshy soil, or the bottoms of drained, shallow lagoons, where vegetable matter has accumulated and added to the humus, are preferred for celery culture. In Texas most of our deep alluvial soils along rivers and creeks offer suitable conditions. In short, any deep, moist soil, but not liable to be waterlogged, rich in humus, either naturally or from manuring, will grow celery. The preparation of the soil calls for deep plowing and thorough pulverization. Stable manure, if well rotted or composted, may be applied to the land immediately after breaking, and harrowed in. As much as twenty tons per acre of such manure may be used to advantage. In fact, what has been said in regard to manure and soils for cauliflower holds equally good for celery and celeriac.

Celery is generally planted in rows about 3½ to 4 feet apart and 7 to 8 inches apart in the rows. Celeriac grown simply for its roots is planted in much closer rows, only far enough apart to admit of horse cultivation, or if cultivated by hand with wheel hoe, 16 to 18 inches is enough distance between the rows. The celery, on the other hand, is cultivated for its large, tender leaf-stems, and to increase their tenderness and milden the flavor, the leaf-stems must be blanched by growing in darkness. There are several methods of producing this etiolation of the leaf-stems, or blanching of the celery plants, as it is called. About two months or a little less time after transplanting into the open ground, the dirt is thrown to the plants from both sides of the row so as to cover up the leaf-stems, leaving only the upper portion of the young leaves exposed to the light. The work is performed with a single stock, called "winged shovel" plow, which moves dirt after the manner of a heel-sweep. The wings are fastened to either side of the shovel and are broader than the heel-sweep. For want of such a special tool, the buzzard-winged sweep, or the solid sweep, may be made to perform the same work. As the leaf-stems lengthen, due to growth in the absence of light, more earth is thrown to them as fast as they emerge above the crest of earth. It is a good precaution to tie the leaf-stems together when this work begins, so as to hold them erect and thus prevent dirt from being thrown in upon the crown of the plant, and thereby hinder the young and later leaves from growth. This blanching is also done by means of 12-inch planks placed edgewise on either side of the row, and so close to the plants that the light is excluded from the leaf-stems. Another method, and a very satisfactory one, is to use 3-inch or 4-inch drainage tiles. This is most easily done by first enveloping the plant in a strong, stiff sheet of manila paper rolled into a cylinder; slipping the tile down over it, then pulling the paper cylinder out. This method is both quick and efficient. As a last method, each plant may be enveloped in a sheet of strong, dark colored paper, and this secured by ties, so as to hold its cylindrical form.

In these methods enough dirt may be thrown to the rows so as to

hold securely the planks, tiles, or paper cylinders against wind or other disturbing agencies.

These methods are preferable to earthing up the entire plant, insofar that they obviate the very deep furrows in the middle, and the leaf-stems remain clean and free from dirt, the contact with which may even produce diseases and spoil the appearance of the celery.

The varieties of celeriac are not numerous, only one or two varieties are generally given in the catalogs of our seed dealers; the same is also true in Europe, where this plant is more generally cultivated. Giant Prague produces a large, turnip-shaped, sweet and tender root which can even be eaten like radishes, in addition to its many other uses. Erfurt, or, as often called, Turnip-rooted Celery, is especially recommended for soups and stews. The true celery occurs in numerous varieties, differing in color and size of leaf-stems. The following are much cultivated: White Plume, which is early and easily blanched; Golden Self-Blanching, also easily blanched, but not as early as the first named; Winter Queen, a robust, stocky growth, very tender, yet one of the hardiest.

*Parsley and Crevil* are vegetables but little cultivated, except near large cities. They demand the same soil and treatment as carrots and parsnip, with the exception that the seed is slow of germination, and ought to be soaked for about ten hours before planting. Planting in frames is the customary method when no large quantities are desired. Of parsley only small quantities are used at a time, hence a few plants in a frame is generally sufficient for home use. The parsley is popular for flavoring soups, salads, and for table ornament. The leaves, the parts used, can be cut every few days, as they are quickly replaced by new ones.

## THE LILY FAMILY—THE ONION.

From the lily family we have only one class of vegetables; namely, the onions, but these fall into several species, such as: *Allium cepa*, or common onion; Shallot, Cive, Leak, and Garlic. But as only the first, the common onion, is of general importance and cultivation in this State, its culture alone will be considered; the others are, however, adapted to similar conditions of climate, soil and culture.

The common onion (*Allium cepa*) is not known in wild condition. Its cultivation goes back to the old Egyptian and Chaldean civilizations. Its probable origin is central Asia. It occurs in numerous varieties, according to form, size, color and flavor of the bulbs. Though preferring a moderately cool climate during early growth, a hot and dry climate is more favorable during the latter stages of the growth. The maturity and keeping qualities reach their highest perfection under those conditions.

Onions demand fertility; the first requirement that the onions make upon the soil is that it be in a high state of fertility, and next, that it be mellow and friable; a loam rich in organic matter and ability to retain moisture, such as alluvial bottom lands with plenty of sand intermixed. Soil not rich in humus and consequent fertility, must be heavily fertilized, either with stable manure or green manure from cowpeas. Stable manure must be well decomposed, if applied directly to the onions; twenty tons to the acre is not a heavy application.

In the four-year series of fertilizer experiments carried on at the Beeville Sub-Station (Bulletin No. 115, Texas Experiment Station) twenty tons of stable manure gave the largest yield. The check plats, which after the first year received a crop of green manure from cowpeas planted after each harvest, showed an immediate increase of 17,771 pounds per acre. The plants having received mixed mineral fertilizers for two successive years in addition to the same dose of green manure, gave no larger crop for that same year; in fact, showed no increase attributable to the commercial fertilizer. This fact may, however, be due to too small an application of commercial fertilizer. The largest amount given per acre was 500 pounds of acid phosphate, 250 pounds of nitrate of soda, and 180 pounds of muriate of potash, the cost per acre of this fertilizer being $21.62. The increase of this plat's yield the second year was 17,840 pounds per acre, which, when compared with the checks, allows very little credit for the commercial fertilizers.

I do not mean to undervalue the importance of commercial fertilizers in onion growing, or in growing other truck crops, but simply emphasize the greater importance of humus.

From Farmers' Bulletin No. 39 of the United States Department of Agriculture, dealing with onion culture, I quote the following expression: "The onion requires a liberal amount of plant food in the most available state. The quantity and quality of manures, which would make potatoes, cabbages, tomatoes, or many other garden crops profitable, will not give a fair compensation in onion culture, unless favored by soils highly fertile in their natural state." The same bulletin states that a yield of 800 bushels of onions per acre would remove from that acre 60.48 pounds of nitrogen, 20.61 pounds of phosphoric acid, and 46.82 pounds of potash.

As already advocated for other crops, where cowpeas are used as a preceding green manure crop, phosphate and potash may be applied to these, and in the cheaper forms, such as floats or ground phosphate rock, and kainit. The costly nitrogen will largely be furnished by the cowpeas and can therefore be greatly reduced in quantity. One hundred to two hundred pounds of sodium nitrate per acre, applied as the bulbs begin swelling, will be sufficient. In close planting this may be broadcasted between the rows and worked into the soil with any proper cultivator. Between rows laid off for horse cultivator this application of fertilizer should be drilled in close to, and alongside of each row, and then mixed with the soil by the cultivator.

There are two methods of raising onions. One is by sowing in seedling or nursery beds, using for the purpose cold frames, which can be properly sheltered from excessive sun or rains. From this place the young onions are transplanted into the open ground as soon as the shanks of the leaves have attained the thickness of an ordinary lead pencil. The other method is to drill the seed into permanent place at once, and afterwards to transplant only for the purpose of securing an even stand in the drills; that is, from places where the stand comes too thick to places where it is too thin.

The former method is followed by nearly all of our gardners, who make onions their specialty. Where onions are transplanted into rows 14 to 16 inches apart, and 5 to 6 inches apart in the row, this transplanting

alone is calculated to cost from forty to forty-five dollars per acre. All Northern experimenters agree that transplanting the onion increases its bulk to double or even triple of that of the untransplanted onion. This is the reason for assuming the extra work and cost. But it must be considered that in the Northern States, where onions are started in hot frames during the winter months, they are transplanted in the midst of their vigor during the spring, when they will have all the advantages of tender seedlings just germinating in the onion field at that time. In the South, particularly Southwest Texas, where the onion seed may be sown in September, both in the open and in framed beds, the difference would scarcely be more than obvious, provided moisture conditions are equal.

Onion seeds, like many other oily seeds, do not keep their germinating power long; the average longevity is stated as being only two years. For this reason, very fresh seed is a necessity for a good stand. For transplanting in close drills, or directly sowing in close drills, 4 to 5 pounds per acre are necessary. For drills intended for horse cultivation one-half of that amount will be sufficient.

In transplanting the young onions it is best to loosen them from the ground with as little injury to the roots as possible; then, as each handful is arranged with the bulbs at even length, the tops are cut back to half their length or even shorter; the roots are also trimmed back to within one inch of the bulb. The method of transplanting consists in marking out the rows and opening up a furrow for each mark, with a hand turning plow; then set the young onions erectly against the land side of the furrow and cover by throwing the dirt back against the plants. It is necessary to firm the dirt against the plants, for only by close contact with the earth are the plants able to quickly resume growth. The proper distance between the bulbs in the drill is 5 to 6 inches.

The time for sowing the seed in the open ground is the same as for sowing nursery beds. In either case, whether irrigation is to be used or the locality is subject to heavy fall rains, the drills should be made on slightly raised beds; because the germinating onion plant is a weakling and readily killed both by standing water and by crusting of the soil. Both evils are greatly obviated by even a slightly elevated position of the bed. Another advantage of having the rows elevated is the ease with which the earth can be worked away from the bulbs, which is a necessity during the latter stages of cultivation, especially where horse cultivation is used. It is a well known fact that onions grown with the bulbs deeply in the soil form thick, sappy necks that fail to dry back to the bulbs at maturity; hence become a seat of decay.

As already stated, onions are very resistant to frost from the time that the bulbs have begun swelling, and the hardiness increases with their growth. As a winter protection for onions started from seed in the open field, it is recommended to plow sufficient dirt to them to cover the bulbs during the coldest part of the winter. After the danger of frost is over this dirt should be worked away from the plants. Frost killing of the tops does not seriously retard the growth.

In dry and hot regions the onions generally mature with ease, the bulbs become firm and the necks dry perfectly back to the bulbs. In moist and

cooler climates the necks are frequently tardy in drying, leaving many immature "bottle necks." To obviate this, it is a common practice in such climates to break the tops down by dragging a plank over the field, crosswise to the length of the rows. Care must be taken that this plank is only heavy enough to break the tops over, but *not bruise the bulbs.* This breaking of the necks promotes their drying back and maturing.

In the drier regions of the State, onions and most other crops require irrigation for successful culture. Two systems are in vogue; namely, irrigation by flooding the ground and by leading the water in the furrows between the rows of the plants. In either case the land must be carefully leveled. In flooding, the land is generally laid off in areas surrounded by low levees, so that the ground of each area can be separately submerged. In the furrow system the land should slope just enough to allow the water to run in the furrows between the beds without moving silt. As soon as the land is dry enough for the cultivator after each irrigation, it must be stirred to prevent crusting. In fact, cultivation under irrigation must be carried out with the same idea of conserving the moisture of the ground as in dry-farming.

For onions irrigation needs to be given once every ten to twelve days, depending on the retentiveness of the soil and the humidity of the atmosphere. Over-irrigation should be carefully avoided, as there is nothing that will so quickly destroy the usefulness of the land. Water should, therefore, be applied rather frequently than heavily.

*Harvesting.*—When the tops are wilted and dried well back to the bulbs, the onions are ready for pulling. Dry weather should be selected for this operation. The onions should be carefully handled so as to cause no bruises. They may be thrown in windrows, where they may be left for further drying and curing. Too long exposure in very warm sun is, however, to be avoided, as this may cause blisters and burns, which will develop decay. So soon as the bulbs are dry enough for the dirt to crumble off, the tops and roots should be trimmed back with a sharp knife or a pair of shears. The crates for onions should have a capacity of about 50 pounds each, and be so constructed as to allow ample aeration. The crates after filling should be placed under a shed where they are kept in the dry and exposed to free circulation of the air.

*Varieties.*—An ideal variety of onion should be: first, a good keeper; second, of good table quality, that is sweet and mild of flavor; third, of good, even size and handsome appearance. The varieties which have reached the highest popularity among the onion growers in Texas are: the Red Bermuda, the White Bermuda, and the Crystal Wax.

An experiment comparing the keeping quality of twenty-eight varieties was carried on at the New Mexico Experiment Station (Bulletin No. 52). The experiment was made for two successive years and the onions were kept under favorable storage conditions each year from August to the twenty-second of January. The following is the precentage of sound bulbs of the best keepers at the end of the experiment:

| | 1902-1903 | 1904-1905 |
|---|---|---|
| 1. American Prize Taker ..... | 90. | .... |
| 2. Australian Brown ..... | 93. | 100. |

| | 1902-1903 | 1904-1905 |
|---|---|---|
| 3. Australian Yellow Globe | 92.5 | .... |
| 4. Extra Early Red | 90. | 95. |
| 5. Giant Gibralter | 95.94 | .... |
| 6. Philadelphia Silver Skin | 96.96 | 90. |
| 7. Round Yellow Danvers | 95. | 100. |

The Bermuda onion and the Crystal Wax were not included in the above keeping test.

*Enemies of Onions.*—The most common insect enemy of onions in Texas is the thrips. It frequently makes its attack on the young plants while in the seedling beds, but also in the open ground. It is a minute sucking insect, causing the plants to lose the green color and become of a dull, or even dirty gray appearance. The plants finally turn brown and die. This trouble is quite common in our onion raising districts. The best remedy against this pest is to apply whale-oil soap emulsion, made as follows: One pound of whale-oil soap dissolved in a gallon of hot water, after thorough stirring add enough water to make four gallons, and stir thoroughly. The mixture is applied lukewarm with a spraying machine. The spray should be applied several times, as the eggs are unaffected by the spray and hatch at intervals of ten days.

## ASPARAGUS.

Asparagus belongs to the Lily of the Valley family, a group of plants closely related to the lilies. Its native habitat is the Atlantic and Mediterranean coasts of Europe. It is found wild even as far north as Scandinavia. Asparagus has been in cultivation for many centuries, yet it is not rich in varieties as most plants of long cultivation. Asparagus is perennial, from an underground stool of root-stalks. It will grow as a weed on most any land, but only on highly enriched land will it produce the thick, succulent, eatable shoots.

For cultivation, well drained sandy loam is preferred. The best preparation for ground intended for asparagus is to trench it to the depth of 18 inches, and mix the soil as the trench is being refilled with one-third to one-half of its bulk of composted manure, well packed or tramped into the trench. To the compost kainit and ground phosphate rock may be added. The trenching may be made either by plow or spade, as convenience demands.

Plants may be bought from seed houses, or raised at home in a well enriched seed bed. Sowing should be done in February, and at the same depth as we would sow English peas, the drills to be far enough apart for convenient hand cultivation. The young plants will begin to come up in a month or six weeks. Thorough cultivation must be given at all times. Mulching the ground, as the hot season comes on, will help to keep the soil cool and retain the moisture. As the plants commence to crowd each other, the weakest are to be weeded out, leaving the best 5 to 6 inches apart in the drill. The asparagus seedlings vary much in vigor; hence, careful selection is to be carried out in thinning the seedlings. There are male and female plants. The males are liable to be the stronger, but can not be picked out the first year, as flowering scarcely occurs that early.

After the young plants have grown for one season in the nursery bed, they are ready to go into the permanent beds, where the soil has been prepared as described above. A furrow 5 to 7 inches deep is opened up for each row to be planted. In planting, the roots should be set on small mounds in the bottom of this furrow, but with the crown 3 to 4 inches below the level of the surface, and at a distance of 3 feet apart in the row. The furrow in which they are planted is then refilled with a sweep or any other convenient tool. Plants not with numerous roots, but rather few and stout roots, are selected and all slender rooted plants are discarded. The best time for this planting in Texas is in the fall. Before the advent of winter, it is well to mulch the bed with manure, which may be coarse and unfermented, without harm. In fact, it is recommended that the beds be given a dressing of such mulch every succeeding winter. A slight sprinkling of common salt will also promote the growth and thriftiness of the plants.

Not until the second, or even the third, spring after the beds have been planted can a crop be expected. The earth should be plowed to the beds in the fall or early in the winter preceding harvesting, before the mulch is distributed. The object of this is to put enough dirt over the crowns so as to cause the blanching of the shoots, since this improves their flavor and tenderness. Not all the shoots that may be large enough should be removed during the first harvest, but only a few, as the plants may be yet too weak to spare a full harvest. After the third year all shoots may be harvested for about two months, or from early in March until May, varying according to the season and locality. After that time cutting should cease, the earth thrown to the rows worked away from them, and cultivation carefully attended to through the entire summer. Late in the fall, when growth has stopped, all over-ground parts of the plants should be removed from the ground, especially seed-bearing branches, since new seedlings are liable to become a pest.

Harvesting the shoots is performed with specially made knives, but can be easily done with any knife, after removing enough dirt from around the shoot to lay bare its base, where the cut is made. Where the earth is hilled up to the depth of 6 inches over the crown, the shoots may be cut as soon as they show their buds above the ground.

It is a general observation that asparagus has less longevity and less vigor in the South than in the cooler climates of the North. This may be attributed to our high summer temperatures, so frequently accompanied with drouth. Heavy mulching of the ground during the hot season would certainly do much towards reducing the temperature of the soil and retaining the moisture.

## RHUBARB.

The cultivated rhubarb comes from the Buckwheat family. Its botanical name is *Rheum hybridum*. The home of its ancestry is supposed to be Central Asia. The parts used are the large fleshy leaf stems, which possess a mild acid flavor, strongly reminding one of that of the gooseberry. Several of its congeners are medicinal. It is probable that the form cultivated as a vegetable is a hybrid. From seed it is very variable, so that it cannot be depended on to come true, or

furnish plants suitable for culture, except by careful selection. It is, therefore, customary to propagate it by division of the root, rather than from seed. Roots may be obtained from the seed houses, or by longitudinal division of the large, old roots which have a crown of buds on the top.

When rhubarb is raised from seed, the seed should be sown the same year as they are produced, and plants for the permanent planting should be selected from the strongest of the seedlings. The seed may be sown in well manured and well drained ground in the fall, winter or early spring. Cold-frames or hot-frames should be used, according to the season or the locality. In the beds the plants should remain for one year, and be properly thinned, so as not to stunt them by crowding. The next fall they are ready for transplanting into permanent beds. They should be planted 1 to 2 inches below the surface of the soil, and at distances of at least 4 feet apart in each direction. By obtaining the roots from seed houses, one year will be saved.

The rhubarb makes the same requirement on the fertility and the texture of the soil as the asparagus; hence, the same incorporation with manure, and the same mulching is necessary, as described for that plant. A rhubarb bed well cared for may give crops for four or five years, when renewal of the stock becomes necessary. New plants can easily be obtained by splitting the old roots, giving to each piece a good bud for the formation of a new crown. During the cultivation it is necessary to prevent flowering, as this will weaken the roots and reduce the size of the leaves. The defoliating for harvest is also weakening to the plants; hence, must not be carried too far, but be done with judgment and by always giving enough leaves to continue the increase of the food supply in the root. In order to increase the length and succulency of the leaf-stems, a small barrel or a keg with bottom and top removed may be placed over the crown of each plant, as growth starts in the early spring. The rhubarb leaves are gathered by some before the blades are unfolded; by others when they are half grown to nearly grown.

For preserving the plants during the hot summer months, heavy mulching of the ground and light shading may be necessary. The summer heat will naturally limit the cultivation of rhubarb in Texas to small patches in the family garden. Rhubarb is, however, a good yielder, so that eight or ten strong plants will be an ample supply for a family. The most common variety of rhubarb is the Victoria, originated in England.

## THE SUNFLOWER FAMILY OR COMPOSITAE.

From this family, which is the largest family of all our flowering plants, we have brought a host of species into our gardens as ornaments, but only a few as garden vegetables. Chief among these are the Salsify or Oyster Plant, growing wild in the moister and cooler regions of our country; Chicory, one form of which is called the Endive; and the Lettuce. The last is the only one of general cultivation.

*Lettuce.*—Lettuce is very resistant to frosts; it may be grown even in the central zone of Texas up to the Christmas holidays without serious danger of destruction from cold. In the Northern States, let-

tuce is more raised under glass during the winter time than any other vegetable. In general, the lettuce prefers a cool and moist climate and a rich, moist soil, the optimum condition thus agreeing with that of the cabbage. The manner of culture, to produce the best results, is also very similar to that of cabbage and cauliflower. Seed may be sown for fall crop in September, either directly into the open field or in cold frames, all according as to whether the condition for germination and growth be favorable for the open field, or not. The distance between the drills may be according to the method of cultivation, whether by horse or hand cultivator. The seed should be planted at a depth of about one-half an inch into the ground. So soon as the plants have set about four leaves they should be thinned to a distance of 6 to 8 inches apart in the row; otherwise they will fail to head. A liberal top-dressing of sodium nitrate stirred into the soil alongside of each row will greatly promote earliness and complete heading.

Plants started in cold frames and kept properly thinned can, after a month's growth, be transplanted into the open ground, at the distance in the rows mentioned above. Nitrate of soda should also be applied as directed above, but not until the plants have recovered from the transplanting, as shown by the resumption of growth.

Sowing of lettuce may be made at intervals of two to three weeks, so as to have a continuity of fresh crops ready for harvest. This is especially necessary when growing for market, as fresh lettuce is in demand at all seasons.

For early spring crop the seed should be sown in hot frames during January, in the northern half of the State; in the southern half, well protected cold frames will be sufficient.

When artificial heat of hot frames or greenhouse is used, the plants must have a season of hardening, either in cold frames or by gradual exposure to colder temperature and stronger light, before they are fit to succeed in the open ground. Transplanting from seedling beds or seedling trays into 2½-inch flower pots is to be highly recommended for lettuce, as for the cabbage, tomatoes and all plants started by similar methods. Potting will especially give rise to plants with large and handsome heads.

The varieties of lettuce enumerated in our seed catalogs are quite numerous, yet their adaptability to the various seasons and their flavors differ much less than their shades of color and other character of minor importance. The Cos, or Romaine varieties, agree in producing an elongated, obovate head. They are much less grown in this country than the cabbage-headed varieties. Very popular among these are: Simpson, Salamander, Hanson, New York, Big Boston, and Mignonette.

### MALLOW OR COTTON FAMILY—OKRA.

The only important vegetable of this family is the Okra, which is a member of the genus Hybiscus. Okra is very easy of cultivation, needing just the same treatment as its relative, the cotton. The seed is planted in open ground so soon as the temperature is suitable for cotton planting. The dwarf varieties which are the earliest to come into bearing should be grown at a distance of 18 inches apart in the drill and about 3 feet between the drills. So soon as the pods have reached the

length of 3 to 4 inches they must be harvested; otherwise they become too tough for use. If all the pods set be constantly harvested at that size, the okra plant will, under good cultivation, continue to bear until frost.

The okra plant is perhaps the most drouth resistant of our vegetables.

Large quantities of okra are used in the North, both in fresh state and for canning. To reduce the wilting of pods during transit to a distant market, they should be cut with one-half to one inch of the fruit's stem attached to the pod.

Okra is a plant that is remarkably free from insects and fungus pests; hence, failures in crops rarely occur, except through neglect of cultivation.

101-214-15M

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR No. 4, NEW SERIES FEBRUARY, 1914

# THE BEST TYPE OF IMPLEMENT SHED FOR TEXAS FARMS

POSTOFFICE:
College Station, Brazos County, Texas

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1914

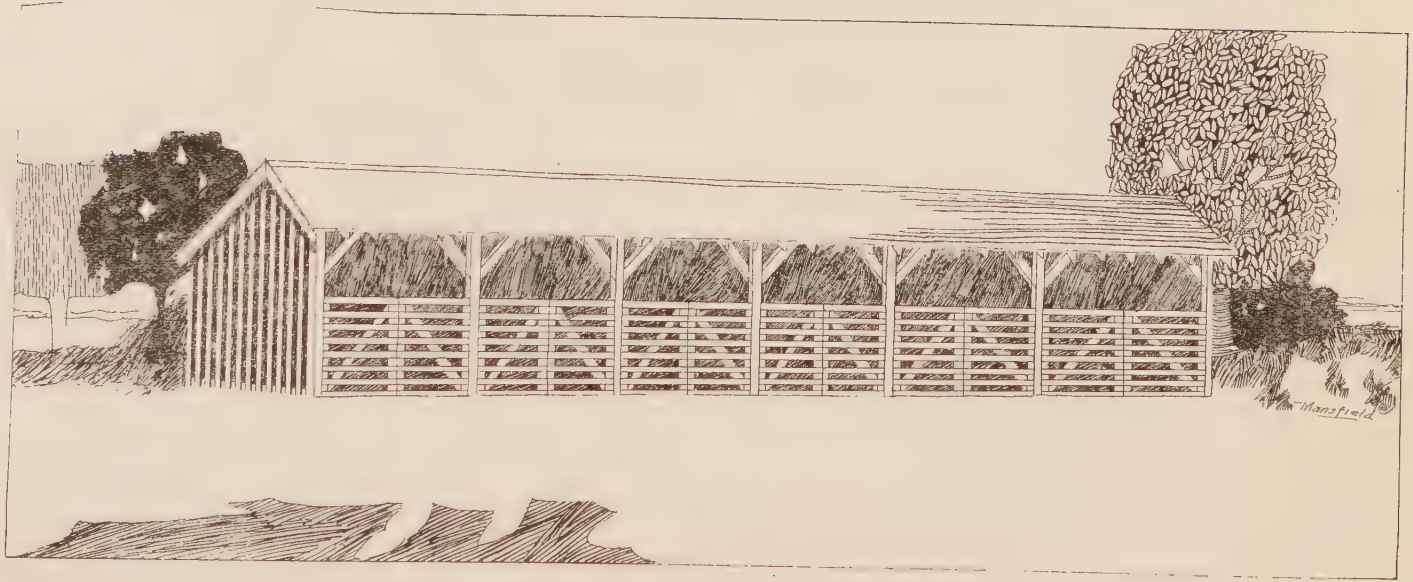



FIGURE 1.—"Best type of implement shed for Texas farms."

# THE BEST TYPE OF IMPLEMENT SHED FOR TEXAS FARMS.

BY B. YOUNGBLOOD, DIRECTOR.

The census of 1910 shows that there were $56,790,260 worth of farm implements and machinery in use in Texas. Assuming that the annual depreciation of implements in this State amounts to ten per cent and that by a little extra use of a lubricant, paint, repairs, and protection from the weather, this depreciation could be reduced to, say, five per cent per annum, the saving in Texas in one year would amount to $2,839,513. Dividing this amount by 417,770 farms in Texas reported by the Federal Census Bureau, we have an average saving of $67.97 a farm a year, or $135.94 in two years. This amount is more than is necessary to build an implement shed of adequate size for some farms, and too little for others. It may be assumed with safety, however, that if all the implements on Texas farms were given reasonable attention and properly housed when not in use, enough money would be saved in two years to build a shed of suitable size on every farm in the State. With the dependable margin of profits in farming very narrow at best, it would seem to be only the part of wisdom for every farmer to properly care for his implements and machinery.

Though Texas farmers may have been more or less negligent in this respect in the past, they are beginning to realize that an appreciable percentage of their income is dissipated through the depreciation of their farm machinery. During the past year the number of requests for information upon the subject of implement sheds has steadily increased. This circular, published in response to the needs of farmers, is based upon farm experience and observations on the care or neglect of implements on a great number of farms in the Southwest, made while the author was in charge of farm management investigations in Texas and Oklahoma, for the United States Department of Agriculture.

The plans and bills of materials have been prepared and carefully checked under the direction of Professor Sam J. Fountain, Professor of Architecture in the A. and M. College of Texas, at College Station. The bills of material have also been checked by an experienced lumberman. The intention is to embody in these plans some of the best ideas extant among the farmers of the State with those of a competent architect so that the sheds will not only prove satisfactory in point of construction, but will stand as long as the materials of which they are constructed may last.

## TYPES OF IMPLEMENT SHEDS.

For convenience, any kind of shelter for implements and machinery is hereinafter referred to as an "implement shed."

There are at least five types of "sheds" to be observed on Texas farms:

1. *Deep, square or rectangular sheds, as shown in Fig. 2.* This is

FIGURE 2.—Type of implement shed that is inconvenient, somewhat wasteful of space, and relatively expensive.

a well built, attractive shed, but is not altogether desirable, for the reason that it is too wasteful of space and therefore relatively expensive. It is open on three sides, making it necessary to set the implements too far in toward the center to house more than two tiers running lengthways. Any shed broader than necessary to house two tiers of implements is naturally inconvenient, because of the fact that the third tier must be placed in the middle, and the implements in one of the outer tiers must always be removed before those of the inner tier can be taken out of the shed. This shed, shown in Fig. 2, is 44x68 feet. If but two tiers of implements are housed under it, a great deal of space is wasted.

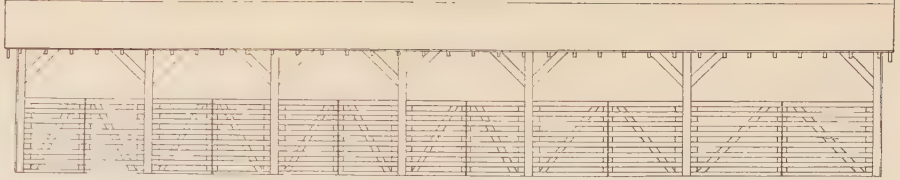
2. *Housing implements inside the horse barn.* Many barns are constructed with a view to housing the implements inside the barn. There are several such barns in Texas, in which all the lower portion of one end is left open for implements, while in the other end are the stalls. This arrangement is objectionable, (a) because of the inconvenience in getting implements in and out of such a place; (b) such space is too expensive for the housing of implements, and (c) implements should never be housed where horses or mules may roam at large, as they are likely to run into them and possibly injure themselves or damage the implements.

3. *Narrow sheds built on the side of the barn.* As a general rule these are constructed too narrow, twelve to sixteen feet deep. This is the cheapest possible type of implement shed, yet it involves the disadvantage of increasing the fire risk, and as a rule is less convenient with reference to stables than separate implement sheds. As a general principle it is safer to build special purpose barns and implement sheds separately, at least one hundred feet from each other, than it is to built a combination barn and implement shed, as the latter is very inconvenient and the fire risk is greater. Another disadvantage is that in case this type becomes too small, it cannot be added to without either creating an odd shaped structure or increasing the size of the entire barn.

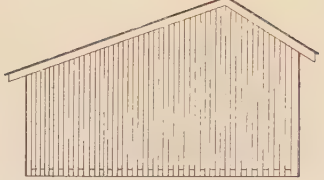
4. *Implement houses.* These are similar to that shown in Fig. 2, if it had walls on four sides and big doors at the ends with a driveway through the center of the building. The chief objections to this type are (a) that it is more expensive per unit of storage capacity than is necessary, and (b) it is not as convenient as it might be.

5. *Special implement sheds built to themselves.* This type is used on the Texas Agricultural Experiment Substations, the Taft Ranch, and a few other farms. *They are considered by many to represent the most desirable type of implement shed that can be built on Texas farms.* They are convenient, eighteen feet deep, with a two-foot overhang roof, which makes the total depth over all, twenty feet. This is deep enough for any implement used on the average farm.

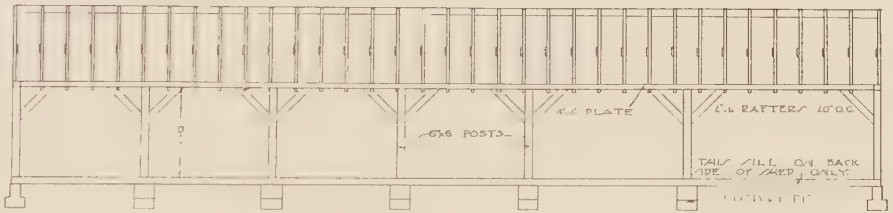
This type possesses the following advantages: It is not expensive, it is not unsightly, the farmer and his laborers can build it, and it is an effective protection to the implements. As additional space is needed, it may be added without changing the appearance of the shed and without increasing the cost per unit of space. It can be built broader, longer, or shorter, if desired. It is shown in Figs. 1 and 3.



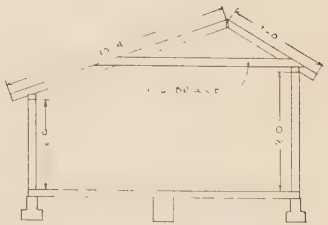
-SOUTH ELEVATION-



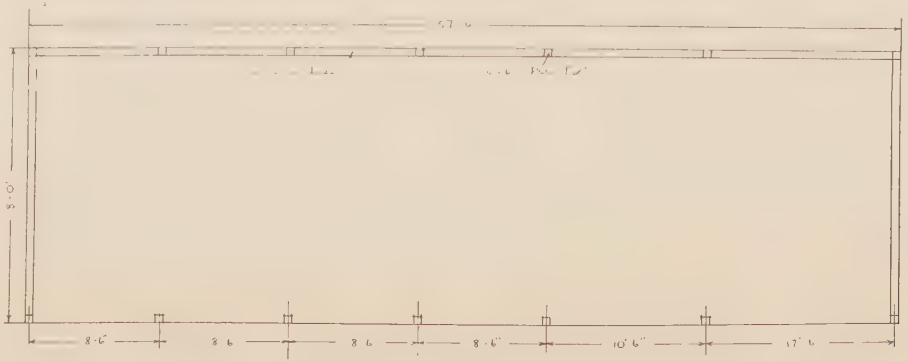
-WEST ELEVATION-




-LONGITUDINAL SECTION-



-TRANSVERSE SECTION-




-GROUND PLAN-

## FOUNDATIONS.

Dr. G. F. Warren, Professor of Farm Management at Cornell University, in his book on farm management, states that—

"* * * It is possible to build a shed that will depreciate as much as the machinery it houses would depreciate if exposed. * * *"

This is possibly true of any implement shed constructed too weak, or of the one which we suggest if built upon an unstable foundation. Let us urge, therefore, that a *permanent* foundation be provided before construction begins. We would recommend either bois d'arc blocks or reinforced concrete piers. The plan shown in Fig. 3 calls for sixteen piers. Bois d'arc blocks six to eight inches in diameter at the top and two feet long, would be of sufficient size. They would cost approximately twenty-five cents each.

If reinforced concrete is used, about sixteen cubic feet will be required to make the piers 8x8 inches at the top, and two feet deep. Old iron rods, pipe, and so forth, can be used for reinforcing. The shed should be anchored by bolts set in the concrete. Concrete consisting of one part of cement, two of sharp sand, and five of crushed rock or clean gravel, should be used. Concrete of this composition will cost about $8.00 per cubic yard, making the cost of the sixteen cubic feet required for the piers, $4.73. These figures, of course, are based upon the assumption that all materials are to be purchased. If sand and gravel are available on the farm, the expense of hauling will not be incurred, and the total cost, of course, will be reduced accordingly.

The piers should stand not more than four inches above the surface of the ground.

If oak blocks are used, they should be dressed and painted with tar or pitch.

## BILL OF MATERIALS.

For shed 57 feet 6 inches long and 18 feet wide with two-foot overhang roof.

*Lumber.*

| Description. | Number Board Feet. |
|---|---|
| 2 pcs. 6x 6—18, end sills | 108 |
| 3 pcs. 6x 6—18, rear end sills | 162 |
| 1 pc. 6x 6—12, rear end sill | 36 |
| 2 pcs. 4x 6—18, end plates | 72 |
| 6 pcs. 4x 6—18, side wall plates | 216 |
| 2 pcs. 6x 6—12, side wall plates | 72 |
| 58 pcs. 1x12— 8, rear walls | 464 |
| 56 pcs. ⅝x 4— 8, battens for rear walls | 150 |
| 18 pcs. 1x12—12, end walls | 216 |
| 16 pcs. ⅝x 4—12, battens for end walls | 64 |
| 7 pcs. 6x 6— 8, posts for gates | 168 |
| 26 pcs. 1x 6—16, strips for gates | 208 |
| 12 pcs. 1x 6—10, braces for gates | 60 |
| 24 pcs. 1x 6—16, ends for gates | 192 |
| 2 pcs. 4x 6—18, braces for posts | 72 |
| 4 pcs. 2x 4—18, braces for end walls | 48 |

| Description. | Number Board Feet. |
|---|---|
| 2 pcs. 4x 6—16, studs for rear walls | 64 |
| 30 pcs. 2x 6—24, rafters | 720 |
| 30 pcs. 1x 6—14, rafter braces | 210 |
| 800 ft. 1x 4 lathing | 800 |
| 160 ft. 1x 6 facia boards | 80 |
| Total | 4182 |

4182 feet of lumber @ $25.00 per thousand ..... $104.55

*Other Materials.*

| | |
|---|---|
| 58 feet ridge roll | $ 4.65 |
| 200 pounds nails | 6.50 |
| 12 pr. "T" hinges | 4.20 |
| 11 thousand prime cypress shingles at $4.00 per thousand | 44.00 |
| Total | $59.35 |

*Foundation.*

Concrete:

16 cubic feet 1:7 mix concrete at $8.00 per cubic yard (16 piers 8x8, 2 feet deep) ..... $4.73

Bois d'arc blocks:

16 bois d'arc blocks 8 inches in diameter at top and 2 feet long, at 25 cents each ..... $4.00

*Summary.*

| | |
|---|---|
| Lumber | $104.55 |
| Other materials | 59.35 |
| Concrete piers | 4.73 |
| Total | $168.63 |

Or—

| | |
|---|---|
| Lumber | $104.55 |
| Other materials | 59.35 |
| Bois d'arc blocks | 4.00 |
| Total | $167.90 |

*Labor.*

Labor ..... days at $..... per day ..... $.....

Total cost of implement shed ..... $.....

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 5, NEW SERIES JANUARY, 1915

# Appropriations Asked

FOR THE

# Main Station and Substations

BIENNUM 1915-16 1916-17

## Information Concerning Experiment Stations in General and the Texas Station in Particular

POSTOFFICE:

College Station, Brazos County, Texas

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 5, NEW SERIES JANUARY, 1915

# Appropriations Asked
FOR THE
# Main Station and Substations
BIENNUM 1915-16 1916-17

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## Information Concerning Experiment Stations in General and the Texas Station in Particular

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BY

B. YOUNGBLOOD, Director

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POSTOFFICE:

College Station, Brazos County, Texas

The Purpose of the Texas Agricultural Experiment Station:

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"TO SOLVE THE PROBLEMS WHICH THE FARMERS ARE NOT PREPARED TO SOLVE FOR THEMSELVES"

## APPROPRIATIONS ASKED FOR THE MAIN STATION AND SUBSTATIONS

Biennum 1915-16 1916-17.

### Information Concerning Experiment Stations in General and the Texas Station in Particular.

By

B. Youngblood, Director.

The experiment stations were created for the purpose of solving the problems which the farmers were not in position to solve for themselves. The information of the stations is carried to farmers and stockmen through the teaching and extension services of the agricultural colleges. It is pretty well agreed that the agricultural colleges are powerful economic agencies when they are properly provided with information to teach students and to disseminate among the people. It follows, therefore, that the experiment stations, which are creative of this information, are fundamental to the success of the agricultural colleges, and must be properly supported. The fact that the agricultural colleges were not successful until the establishment of the experiment stations verifies these conclusions..

The following are the lines of work being conducted by the Texas Station at this time:

Veterinary Science.
Agricultural Chemistry.
Horticulture,
Animal Husbandry,
Entomology,
Agronomy,
Plant Pathology and Physiology,
Farm Management,
Poultry Husbandry,
Feed Control Service.

How fruitful of results a given experiment station may prove to be depends largely upon how wisely it is planned and how well it is supported.

That the Texas Experiment Station has been abundantly fruitful of results, considering the little support it has had, must be admitted. Dr. Francis' investigation of Texas Fever has been worth many millions of dollars to the cattle industry of the State. All appropriations that the Station ever received dwindle into obscurity as compared to the value of this work. The chemical investigations have yielded valuable information concerning the properties of Texas feeding stuffs and soils. The agronomic work is not only giving us a greater variety of better crops, but better methods of crop improvement and crop production, and has introduced and distributed Sudan, a universally adapted hay grass,—a high yielder, highly palatable and nutritious, and fitting well into Texas cropping systems. Last year the farmers who grew it received more than fifty thousand dollars for the crop. This year it is bringing Texas farmers more than a million dollars for the seed alone, to say nothing of about twenty thousand tons of the hay which is being utilized on the farms. Sudan grass goes far toward keeping at home the two hundred and fifty to three hundred millions of dollars annually expended outside the State for feedstuffs and foodstuffs. The steer feeding work, in which silage has been proven to be the best and cheapest roughage for beef production, has also more than verified the value of the Texas Station. Attention is called just here to the fact that it has been necessary for us to conduct this work on borrowed money and personally stand the responsibility.

It is impossible in so brief a space to outline and discuss the several thousand experiments, tests, investiga-

tions and researches under way on the Station. For detailed information, see annual reports of the Station.

## COMPARISONS

The reader may be interested in comparing the amounts of money spent in Texas for experiment station work with the amounts spent for this purpose by other states. The following tables show the amounts expended for experiment station work by six of the leading States of the Union, including Texas:

FEDERAL, STATE AND TOTAL FUNDS EXPENDED FOR EXPERIMENT STATION WORK, PER SQUARE MILE.

| State. | Area in square miles. | Appropriation of Federal State, and miscellaneous funds. | Federal funds per sq. mi. | State and miscellaneous funds per sq. mile. | Total Federa, State and miscellaneous funds per sq. mi. |
|---|---|---|---|---|---|
| Ohio ..... | 41,040 | $411,674.25 | $0.73 | $9.30 | $10.03 |
| Illinois ..... | 56,665 | 236,040.33 | 0.53 | 3.63 | 4.16 |
| New York .. | 49,204 | 152,218.02 | 0.61 | 2.48 | 3.09 |
| Iowa ..... | 56,147 | 111,524.44 | 0.55 | 1.45 | 2.00 |
| Missouri ... | 69,420 | 119,599.13 | 0.43 | 1.29 | 1.72 |
| TEXAS .... | 265,896 | 89,590.07 | 0.11 | 0.22 | 0.33 |

FEDERAL, STATE AND TOTAL FUNDS FOR EXPERIMENT STATION WORK, PER FARM.

| State. | No. farms in State. | Appropriation of Federal State, and miscellaneous funds. | Federal funds per farm. | Local and other funds per farm. | Total Federal, State, local and misceellaneous funds per farm. |
|---|---|---|---|---|---|
| Ohio ..... | 272,045 | $411,674.25 | $0.11 | $1.40 | $1.51 |
| Illinois ..... | 251,872 | 236,040.33 | 0.11 | 0.818 | 0.928 |
| New York .. | 215,597 | 152,218.02 | 0.138 | 0.566 | 0.704 |
| Iowa ..... | 217,044 | 111,524.44 | 0.137 | 0.37 | 0.507 |
| Misssouri ... | 277,244 | 119,599.13 | 0.108 | 0.32 | 0.428 |
| TEXAS .... | 417,770 | 89,590.07 | 0.07 | 0.14 | 0.21 |

## WHAT CONSTITUTES AN EXPERIMENT STATION.

In order to have a concrete basis upon which to develop our ideas concerning an experiment station, let's see what an experiment station is composed of. It consists of

(1) Specialists. These men must have long training and experience in their specialties. They must be men who are devoting their lives to the work.

(2) "Tools" or apparatus and equipment with which to work. Special equipment is necessary for every line pursued.

(3) Places to work. Specialists cannot work to best advantage out of doors. They need greenhouses, laboratories and experiment fields.

The Texas Experiment Station has the men and the fields, but we are still short of the necessary laboratories, and by far short of the necessary equipment, both at the Main Station laboratories and on the various experiment farms of the State.

**EXPERIMENT STATION BUILDING.** For three years we have been calling attention to the fact that our present Experiment Station building is inadequate for the purposes intended. A building twice the size of the present one would be about the right size for the station work at the present time. The necessity of requesting an appropriation of one hundred thousand dollars for an Experiment Station building was obviated by a suggestion made by the President of the Board of Directors, Hon. E. B. Cushing, and the President of the College, Dr. W. B. Bizzell. This was to the effect that any profits accruing from the Feed Control Service after September 1, 1915, would be used by them for this purpose. If this plan of providing an Experiment Station building is agreeable to the Legislature, no State appropriation will be necessary for this purpose. It is the poorest of economy to have the station continue to operate largely out-of-doors for two years or more to come. The present building is about the right size for our chemistry work alone.

**EXTENDING THE INFORMATION OF THE EXPERIMENT STATION.** The information of the Experiment Station is being disseminated to every nook and corner of the State. It appears in various forms:

(1) as Station bulletins and circulars;
(2) as correspondence;
(3) through the Demonstration Agents in various parts of the State;
(4) in the weekly and daily press;
(5) through the extension service, which consists of correspondence, correspondence courses, short schools, lectures, newspaper articles, special campaigns, and so forth;
(6) in the textbooks used in the grades, the high schools, and the agricultural colleges.

It is gratifying indeed to observe that Texas farmers and stockmen are not only coming to appreciate experiment station ideas, but are putting the information into harness on the farms and ranches in a profitable manner. A few years ago the Station received a few letters each day; not enough, however, to fully occupy the time of one stenographer. At the present time it is not at all an uncommon thing for as many as two hundred letters to come in the Director's mail during a single day, and in cases of emergency the number of letters received by the Station often runs up to several hundred during a given day.

During the last fiscal year the Experiment Station published 170,000 copies of bulletins, circulars and reports. Of this number 135,600 copies were mailed out to those interested, leaving us only 34,400 copies to meet subsequent demands. The Station has written more than fifty thousand letters, giving information to farmers and stockmen, and has published through the press hundreds of special articles dealing with various subjects of common interest.

**ESTIMATES.** The estimates which follow are based upon (1) past expenses and inventories, and (2) our present needs. Four years ago the stations were largely unimproved tracts of land. Some of the fields were cleared and some were not. There were few buildings at that time. We have never asked for and have never received an annual appropriation large enough to buy everything at once. We have pursued the wiser policy of asking for only enough funds to give the stations a gradual development. We have asked only for enough to add a little each year to the equipment and keep certain experiment work going. This policy gave us ample time in which to consider each and every project undertaken, and every expenditure. Each year we have purchased such equipment as we could of the kind that we were not able to afford the previous year.

In addition to equipment, we have endeavored to provide help enough to farm the land, and in addition enough help to experiment with the various crops, rather than to just grow them. Both the improvements and the work so far accomplished, therefore, represent nothing more or less than such of the bare necessities as we were able to buy with the funds made available by the legislature.

We have accepted the appropriations in the spirit they were given. We have assumed that the State wanted us to do all that we could with these funds, but to go no further. For this reason we have been exceedingly careful to apportion our funds each year in accordance with our impressions as to what constituted the most needed lines of experiment work, and accordingly the most needed kinds of equipment with which to do this work. Though the demands made upon us by the farmers and stockmen of Texas have been many times greater than the work under way

would satisfy, we have been exceedingly careful to stay within the limits of the appropriations.

In making these estimates we have assumed that the people of the State want us to keep the experiment farms in as good a state of repair at least as a typical, profitable Texas farm.

All buildings so far constructed have been carefully designed especially for the purposes which they are intended to serve. Our policy is to construct all farm buildings substantially of wood on concrete piers or foundations. No building materials have been used which are inaccessible to farmers. On none of the farms will there be found anything gorgeous, fancy or more expensive than any progressive farmer cultivating an equal amount of land would choose to install. Attractiveness, usefulness and durability have been the prime considerations. The wisdom of this policy is attested to by the fact that many Texas farmers have recently built cottages, barns, implement sheds, poultry houses and seed houses from plans of the buildings on our experiment farms. It may be interesting to know that some farmers of other states are also following these plans.

The scientific work of the Station is conducted in accordance with the best methods employed on the best experiment stations in the country. Some original methods of investigation have been developed by us, but no method is employed in connection with Station work until it has been found to be both economical and productive of dependable results.

In the handling of Station funds we take great pride in the fact that we have developed business methods which conserve the public funds as well as those of any successful business enterprise, or even the Federal Government itself. Our system is concise, and yet complete. Every expenditure is covered by a requisition-order, a voucher, and a re-

ceipt which is used as a subvoucher. From records of the Station any citizen of Texas can, if he likes, ascertain the various purposes for which the funds are expended. Financial statements in our annual reports show not merely that the money has been expended, but how and for what it has been spent.

No funds are being asked for with which to duplicate the work of the State Department of Agriculture or that of any of the institutions engaged in teaching agriculture. It is one of the functions of the Station to furnish these agencies with the information which they teach their students or extend to the people of the State through their extension services. The stations are experiment, rather than demonstration, farms.

The following appropriations asked for the biennum 1915-16 1916-17, have been approved by the President of the College, Dr. W. B. Bizzell; the Governing Board, State Substations, and the Board of Directors of the Agricultural and Mechanical College of Texas:

MAIN STATION.

| | 1915-16. | 1916-17. |
|---|---|---|
| Salaries | $12,000.00 | $12,000.00 |
| General expenses | 6,000.00 | 6,000.00 |
| Main Station (Agronomy) Farm | 5,000.00 | 5,000.00 |
| Veterinary Investigations | 5,000.00 | 5,000.00 |
| Plant Pathology Investigations | 1,000.00 | 1,000.00 |
| Entomology Investigations | 10,000.00 | 10,000.00 |
| Farm Management Investigations | 3,000.00 | 3,000.00 |
| Soil Survey Work | 5,000.00 | 5,000.00 |
| | $47,000.00 | $47,000.00 |

SUBSTATIONS.

| | | |
|---|---|---|
| For eleven substations, including Chillicothe, @ $6,000.00 each | $66,000.00 | $66,000.00 |
| Substation No. 6, Denton | 7,500.00 | 7,500.00 |
| Steer feeding experiments | $5,000.00 | $5,000.00 |
| Dairy feeding and breeding investigations | 3,000.00 | 3,000.00 |
| Poultry feeding and breeding investigations | 2,500.00 | 2,500.00 |
| Sheep feeding and breeding investigations | 3,000.00 | 3,000.00 |
| Swine feeding and breeding investigations | 4,000.00 | 4,000.00 |

| | | |
|---|---|---|
| Goat breeding and improvement investigations | 2,500.00 | 2,500.00 |
| Publication of Station bulletins, circulars, and so forth | 7,500.00 | 7,500.00 |
| | $101,000.00 | $101,000.00 |

*RECAPITULATION.*

| | |
|---|---|
| Total annual appropriation requested for Main Station | $ 47,000.00 |
| Total annual appropriation requested for substations | 101,000.00 |
| Total annual appropriation requested | 148,000.00 |
| Main Station for biennum | $ 94,000.00 |
| Substations for biennum | 202,000.00 |
| Total for biennum | $296,000.00 |

Beginning with the Main Station at College Station, abstracts of the estimates follow:

## MAIN STATION.

| | 1915-16 | 1916-17. |
|---|---|---|
| SALARIES | $12,000.00 | $12,000.00 |

**Explanation:**

This item is divided as follows:

| | 1915-16. | 1916-17. |
|---|---|---|
| B. Youngblood | $1,600.00 | $1,600.00 |
| A. B. Conner | 1,320.00 | 1,320.00 |
| A. S. Ware | 750.00 | 750.00 |
| C. A. Felker | 560.00 | 560.00 |
| A. H. Leidigh | 1,200.00 | 1,200.00 |
| H. H. Jobson | 600.00 | 600.00 |
| J. M Jones | 2,000.00 | 2,000.00 |
| T. J. Conway | 1,200.00 | 1,200.00 |
| C. A. Case | 600.00 | 600.00 |
| Mattie Thomas | 450.00 | 450.00 |
| G. P. Wagner | 900.00 | 900.00 |
| C. L. Durst | 300.00 | 300.00 |
| Reserve | 520.00 | 520.00 |
| Total | $12,000.00 | $12,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| GENERAL EXPENSES | $6,000.00 | $6,000.00 |

**Explanation:**

This item includes freight, express, office supplies of all kinds, equipment, such as filing cases, desks, chairs, tables; postage, stationery, telephone, telegraph, and other expenses of general nature which are encountered in the operation of the Station system, divided as follows:

| | 1915-16. | 1916-17. |
|---|---|---|
| Postage, stationery, office supplies, and so forth | $2,000.00 | $2,000.00 |
| Travel, including per diem and expenses of Governing Board | 3,500.00 | 3,500.00 |
| Freight and express | 350.00 | 350.00 |
| Furniture and fixtures | 150.00 | 150.00 |
| Total | $6,000.00 | $6,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| MAIN STATION (AGRONOMY) FARM | $5,000.00 | $5,000.00 |

Explanation:

| | | |
|---|---|---|
| Labor (4 hands @ $35 00 mo.) | $1,680.00 | $1,680.00 |
| Office furniture (record file) | 40.00 | 10.00 |
| Office supplies | 30.00 | 30.00 |
| Freight and Express | 30.00 | 30.00 |
| New barn (no barn now) | 1,800.00 | ..... |
| Superintendent's house | ..... | 1,200.00 |
| Implement shed | 400.00 | ..... |
| Greenhouse | ..... | 900.00 |
| Tenant house | 400.00 | ..... |
| Seed house | ..... | 775.00 |
| Fences | 250.00 | 50.00 |
| Disk | 35.00 | ..... |
| Cultivator | ..... | 35.00 |
| Plow | 55.00 | ..... |
| Repairs on thresher and engine | 75.00 | ..... |
| Wagon | ..... | 90.00 |
| Wagon box | 15.00 | ..... |
| Harness | 40.00 | 40.00 |
| For miscel. tools and small implements | 50.00 | 65.00 |
| Reserve | 100.00 | 100.00 |
| Total | $5,000.00 | $5,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| VETERINARY INVESTIGATIONS | $5,000.00 | $5,000.00 |

Explanation:

For sheds, pens, and necessary labor and equipment in connection with Texas Fever and *Infectious Anaemia* investigations of the Station, under supervision of Dr. M. Francis.

| | 1915-16. | 1916-17. |
|---|---|---|
| PLANT PATHOLOGY INVESTIGATIONS | $1,000.00 | $1,000.00 |

Explanation:

For laboratory equipment, labor, travel, and miscellaneous expenses incident to investigations of corn smut, blossom-end blight of melons, citrus canker, and other crop diseases, already under way.

| | 1915-16. | 1916-17. |
|---|---|---|
| ENTOMOLOGY INVESTIGATIONS | $10 000.00 | $10,000.00 |

Explanation:

For foul brood inspection and investigation work, and insect investigations, as follows:

| | 1915-16. | 1916-17. |
|---|---|---|
| To pay bee colony inspectors as required by the law placing this work under the Entomologist of the Texas Experiment Station..... | $5,000.00 | $5,000.00 |
| Salary of Assistant Entomologist who will have supervision of cases in court for violation of foul brood law and conduct of investigations with foul brood and means of eradication.. | 1,800.00 | 1,800.00 |
| Traveling expenses of Entomologist and Assistant in connection with foul brood and other investigations ..... | 800.00 | 800.00 |
| Salary of one stenographer ..... | 800 00 | 800.00 |
| Labor, postage, stationery, telephone, telegraph, office supplies, chemical accessories, freight, express, insect containers, printing, and miscellaneous expenses ..... | 1,600.00 | 1,600 00 |
| Total ..... | $10,000.00 | $10,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| FARM MANAGEMENT INVESTIGATIONS... | $3,000.00 | $3,000.00 |

Explanation:

This item includes salaries and traveling expenses of farm management experts, and other expenses incident to conducting farm surveys and the collection of other economic data having a bearing upon farm management problems.

| | 1915-16. | 1916-17. |
|---|---|---|
| SOIL SURVEY WORK..... | $5,000.00 | $5,000.00 |

New Work.

Explanation:

To be expended for soil survey work in Texas, in cooperation of the Bureau of Soils, United States Department of Agriculture. The Bureau of Soils will apportion an equal amount for cooperative soil survey work in Texas, and this money is to be expended for salaries, traveling expenses, and equipment, for soil survey parties.

## SUBSTATIONS:

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 1, BEEVILLE..... | $6,000.00 | $6,000.00 |

ESTIMATE:

| | | |
|---|---|---|
| Salary of Superintendent, Trained Investigator.. | $1,620.00 | $1,620.00 |
| Skilled Labor ..... | 600 00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year..... | 1,704.00 | 1,704.00 |

| | | | |
|---|---|---|---|
| Office Furniture and Fixtures (Filing Case) | | 38.00 | 10.00 |
| Office Supplies | | 60.00 | 60.00 |
| Freight and Express | | 52.00 | 55.00 |
| Travel | | 100.00 | 100.00 |
| Repairs and Buildings: | | | |
| Miscellaneous | | 50.00 | 50.00 |
| Tenant House | | 350.00 | .... |
| Repairs, Office Building and Seed House | | ..... | 200.00 |
| Painting | | 128.00 | ..... |
| Fencing | | 100.00 | 100.00 |
| Repairs, Barn | | ..... | 250.00 |
| Windmill | | ..... | 40.00 |
| Seeds, Plants and Trees | | 200.00 | 200.00 |
| Fertilizers | | 50.00 | 50.00 |
| Feedstuff (Cottonseed Meal and Salt) | | 50.00 | 50.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $ 7.00 | | |
| Books as per list | 15.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 223.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Plate Camera | 75.00 | | 235.00 |
| Farm Machinery, Implements and Tools: | | | |
| Cultivator | | ..... | 35.00 |
| Gas, Oil, Etc | | 75.00 | 75.00 |
| Miscellaneous | | 50.00 | 50.00 |
| Orchard Heaters and Spraying Tools | | 200.00 | 166.00 |
| Live Stock | | .00 | .00 |
| Land | | .00 | .00 |
| Miscellaneous Supplies: | | | |
| Orchard Heat and Spray Material | | 200.00 | 200.00 |
| Harness | | 50.00 | 50.00 |
| Surplus | | 100.00 | 100.00 |
| Total | | $6,000.00 | $6,000.00 |

| | | 1915-16. | 1916 17. |
|---|---|---|---|
| SUBSTATION NO. 2, TROUP | | $6,000.00 | $6,000.00 |
| ESTIMATE. | | | |
| Salary of Superintendent, Trained Investigator | | $1,620.00 | $1,620.00 |
| Skilled Labor | | 900.00 | 900.00 |
| Unskilled Laborers @ $426.00 per year | | 1,704.00 | 1,704.00 |
| Furniture and Fixtures, Office (Filing Case) | | 38.00 | 50.00 |
| Office Supplies | | 60.00 | 60.00 |
| Freight and Express | | 50.00 | 50.00 |
| Traveling Expenses | | 75.00 | 100.00 |
| Repairs and Buildings: | | | |
| General Repairs | | 50.00 | 75.00 |
| Repairs on Barn | | 100.00 | |
| Repairs on Fence | | 50.00 | 50.00 |
| Painting all Buildings | | | 200.00 |
| Chicken House | | 30.00 | |
| Repairs to room in Office building for work of threshing and cleaning seeds | | 100.00 | |
| Poultry Fencing | | 20.00 | |
| Seeds and Plants | | 200.00 | 200.00 |
| Fertilizers | | 201.00 | 225.00 |
| Feedstuffs, including Salt and Cottonseed Meal. | | 50.00 | 50.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $ 7.00 | | |
| Books as per list | 19.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Sunshine Recorder | 100.00 | | 260.00 |
| Farm Machinery, Implements and Tools: | | | |
| Miscellaneous Implements and Small tools. | | 50.00 | 50.00 |
| Plow | | 50.00 | |
| Fanning Mill | | 30.00 | |
| Saw (very necessary) | | 20.00 | |
| Ditching Plow for Tile Drains | | 25.00 | |
| Live Stock | | .00 | .00 |
| Land | | .00 | .00 |
| Miscellaneous Supplies: | | | |
| Orchard Spraying Materials | | 40.00 | 40.00 |
| Tile for Drain in Fertilizer Experiment | | 200.00 | |

| | | | |
|---|---|---|---|
| Horseshoeing | | 10.00 | 10.00 |
| Tile Drains | | | 176.00 |
| Two Sets of Harness | | | 80 00 |
| Surplus | | 100.00 | 100.00 |
| Total | | $6,000.00 | $6,000.00 |
| | | 1915-16. | 1916-17. |
| SUBSTATION NO. 3, ANGLETON | | $6,000.00 | $6,000.00 |

ESTIMATE.

| | | | |
|---|---|---|---|
| Salary of Superintendent, Trained Investigator | | $1,620.00 | $1,620.00 |
| Skilled Labor | | 600.00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | | 1,704.00 | 1,704.00 |
| Office Furniture and Fixtures (has none now): | | | |
| Desk, Chair, Filing Case and Book Case | | 111.00 | 10.00 |
| Office Supplies | | 60.00 | 60.00 |
| Freight and Express | | 50.00 | 50.00 |
| Traveling Expenses | | 75.00 | 75.00 |
| Repairs and Buildings: | | | |
| Hen House and Yard | | 50.00 | |
| Office Building, Seed Room and Exhibit Room | | 400.00 | |
| Tenant House | | | 275.00 |
| Tool Shed | | | 111.00 |
| Seeds and Plants | | 200.00 | 200.00 |
| Fertilizers | | 50.00 | 50.00 |
| Feedstuffs, including Salt and Cottonseed Meal | | 200.00 | 100.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $ 7.00 | | |
| Books as per list | 19.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Plate Camera | 75 00 | | |
| Sunshine Recorder | 100.00 | | 335.00 |
| Farm Machinery, Implements and Tools: | | | |
| Miscellaneous Implements and Tools | | 50.00 | 50.00 |
| Plow | | 50.00 | |
| Fanning Mill | | 30.00 | |

| | | | |
|---|---|---|---|
| Cultivator | | 35.00 | |
| Spraying Appliances | | 50.00 | |
| Wagon | | | 80.00 |
| Ditching Plow for Tile Drains | | 25.00 | |
| Live Stock | | .00 | .00 |
| Land | | .00 | .00 |
| Miscellaneous Supplies: | | | |
| Shock Covers | | 50.00 | 30.00 |
| Tile for Drains | | 200.00 | 500.00 |
| Spraying Supplies | | 23.00 | 10 00 |
| Harness | | 40.00 | 40.00 |
| Surplus | | 100.00 | 100.00 |
| Total | | $6,000.00 | $6,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 4, BEAUMONT | $6,000.00 | $6,000.00 |

ESTIMATE.

| | | | |
|---|---|---|---|
| Salary of Superintendent, Trained Investigator | | $1,620.00 | $1,620.00 |
| Skilled Labor | | 600.00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | | 1,704.00 | 1,704.00 |
| Furniture and Fixtures, Office | | 60.00 | 60.00 |
| Office Supplies | | 60.00 | 60.00 |
| Freight and Expresss | | 50.00 | 50.00 |
| Traveling Expenses | | 100.00 | 100.00 |
| Repairs and Buildings: | | | |
| Miscellanecus Repairs | | 50.00 | 50.00 |
| Tenant House | | 300.00 | 300.00 |
| Fence Repairs and Gates | | 69.00 | 50.00 |
| Seeds and Plants | | 200.00 | 150.00 |
| Fertilizers | | 50.00 | 50.00 |
| Feedstuffs, including Grain, Salt, and Cotton-seed Meal | | *200.00 | *100.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $7.00 | | |
| Books as per list | 19.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |

The only "barn" on the Main (Agronomy) Farm at College Station. Attention is called to the fact that this farm is and has been supported out of a limited amount of Federal funds, which cannot be used for building purposes. We are asking $5,000.00 per annum for equipping and better maintaining this farm.

| | | |
|---|---|---|
| Plate Camera ..... 75 00 | | |
| Sunshine Recorder ..... 100.00 | | 335.00 |
| Farm Machinery, Implements and Tools: | | |
| Miscellaneous Implements and Tools..... | 50 00 | 50.00 |
| Disc Harrow ..... | 40.00 | |
| Ditching and Levee Tools..... | 200.00 | |
| Drill ..... | | 50.00 |
| Thresher for Plats..... | | 200.00 |
| Plows ..... | | 75.00 |
| Spraying Outfit ..... | | 50.00 |
| Live Stock ..... | .00 | .00 |
| Purchase of Land..... | .00 | .00 |
| Miscellaneous Supplies: | | |
| Shock Covers ..... | 150.00 | 61.00 |
| Tile Drains ..... | 200.00 | 200.00 |
| Sprays ..... | 10.00 | 15.00 |
| Harness and Horse Shoes ..... | 20.00 | 30.00 |
| Surplus ..... | 100.00 | 100.00 |
| Total ..... | $6,000.00 | $6,000.00 |

*Allowed because insufficient money for good drainage has handicapped production of feedstuffs.

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 5, TEMPLE..... | $6,000.00 | $6,000.00 |
| **ESTIMATE.** | | |
| Salary of Superintendent, Trained Investigator.. | $1,920.00 | $1,920.00 |
| Skilled Labor ..... | 600.00 | 600.00 |
| Unskilled Laborers, @ 426.00 per year..... | 1,440.00 | 1,704.00 |
| Office Furniture and Fixtures, Desk, File Case | | |
| Book Case ..... | 94.00 | 10.00 |
| Office Supplies ..... | 60.00 | 60.00 |
| Freight and Express..... | 50.00 | 55.00 |
| Traveling Expenses ..... | 100.00 | 100.00 |
| Repairs and Buildings: | | |
| Tenant House ..... | 350.00 | |
| Miscellaneous Repairs ..... | 75.00 | 75.00 |
| Fences ..... | 50.00 | 50.00 |
| Painting ..... | | 100.00 |
| Seeds and Plants..... | 150.00 | 150.00 |
| Fertilizers (Lime and Phosphate)..... | 25 00 | 25.00 |
| Feedstuffs (Cottonseed Meal and Salt) ..... | 50 00 | 50.00 |
| Scientific Apparatus: | | |
| Drawing Instruments ..... ....$ 7.00 | | |
| Books as per list..... 19.00 | | |
| Thermometer (Tank and Soil).... 22.00 | | |
| Bell Jars ..... 5.00 | | |
| Pocket Meter ..... 2.50 | | |
| Farm Level and Sight..... 10.00 | | |
| Graduate and Beakers..... .. 5.00 | | |
| Calipers ..... 2.50 | | |
| Tortion Balances ..... 35.00 | | |
| Grain Testers ..... 18 00 | | |
| Grain Pans ..... 6.00 | | |
| Small Hand Gin (single stalk cotton) 15.00 | | |
| Single Head Thresher..... 5 00 | | |

| | | | |
|---|---|---|---|
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Plate Camera | 75.00 | | |
| Sunshine Recorder | 100.00 | | 335.00 |
| Farm Machinery, Implements and Tools: | | | |
| Row Binder | | 125.00 | |
| Miscellaneous Implements and Tools | | 50.00 | 75.00 |
| Spaulding's Deep Tilling Plow | | 150.00 | |
| Plow | | | 65.00 |
| Disc Harrow | | | 40.00 |
| Live Stock | | .00 | .00 |
| Purchase of Land | | .00 | .00 |
| Miscellaneous Supplies | | 80.00 | 150.00 |
| Tile Drain | | 200.00 | 250.00 |
| Stakes | | 40.00 | 40.00 |
| Shock Covers | | 64.00 | 46.00 |
| Surplus | | 100.00 | 100.00 |
| Total | | $6,000.00 | $6,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATICN NO. 6, DENTON | $7,500.00 | $7,500.00 |
| **ESTIMATE.** | | |
| Salary of Superintendent, Trained Investigator | $1,620.00 | $1,620.00 |
| Skilled Labor | 600.00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | 2,556.00 | 2,556.00 |
| Office Furniture and Fixtures (Has none now) | | |
| Desk, Chairs, Filing Case, Book Case | 111.00 | 10.00 |
| Office Supplies | 60.00 | 60.00 |
| Freight and Express | 50.00 | 50.00 |
| Traveling Expenses | 85.00 | 85.00 |
| Repairs and Buildings: | | |
| Moving and Repair of Barn and Dwelling House | 150.00 | 50.00 |
| Painting Buildings | 30.00 | 50.00 |
| Fences and Repairs | 100.00 | 100.00 |
| Implement Shed | 300.00 | |
| Tenant House | 400.00 | 100.00 |
| Threshing Shed and Engine House (Concrete Floor) | 100.00 | 340.00 |
| Granary and Repairs | 50.00 | 350.00 |
| Poultry Houses and Yards | 30.00 | 75.00 |
| Water Supply | 25.00 | 275.00 |
| Seeds and Plants | 150.00 | 150.00 |
| Fertilizers | | 25.00 |
| Scientific Apparatus: | | |
| Drawing Instruments $ 7.00 | | |
| Books as per list 19.00 | | |
| Thermometer (Tank and Soil) 22.00 | | |

| | | | |
|---|---|---|---|
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35 00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Plate Camera | 75 00 | | |
| Sunshine Recorder | 100.00 | | 335.00 |
| Farm Implements and Machinery: | | | |
| Miscellaneous Tools and Implements | | 50.00 | 59.00 |
| Plow | | | 55 00 |
| Plow | | | 40.00 |
| Row Binder | | 125.00 | |
| Cultivator | | | 35.00 |
| Windmill | | 75.00 | |
| Wagon Scales | | 80.00 | |
| Corn Sheller | | 10.00 | |
| Feed Grinder | | | 30.00 |
| Wagon | | | 90.00 |
| Spray Pump | | 10.00 | |
| Engine | | 300.00 | |
| Live Stock | | .00 | .00 |
| Purchase Land | | .00 | .00 |
| Miscellaneous Supplies: | | | |
| Shock Covers | | 50.00 | 200.00 |
| Harness | | 50.00 | 50.00 |
| Spray Material | | 6.00 | 10.00 |
| Surplus | | 100.000 | 100.00 |
| Total | | $7,500.00 | $7,500.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 7, SPUR | $6,000.00 | $6,000.00 |
| **ESTIMATE.** | | |
| Salary of Superintendent, Trained Investigator | 1,500.00 | 1,500.00 |
| Skilled Labor | 600.00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | 1,704.00 | 1,704 00 |
| Office Furniture and Fixtures, Record Case and Book Case (Has a desk and chair) | 55.00 | 10.00 |
| Office Supplies | 60.00 | 60.00 |
| Freight and Express | 100.00 | 100.00 |
| Traveling Expenses | 120.00 | 120.00 |
| Repairs and Buildings: | | |

This cut shows the condition of the "barn" in which Dr. Francis has conducted all the Texas Fever work during the past twenty-eight years. It is in a still worse condition now. We are asking for $5,000.00 per annum for the construction of barns and pens and the maintenance of this work.

| | | | |
|---|---|---|---|
| Miscellaneous Repairs | | 50.00 | 50.00 |
| Tenant House | | 475.00 | |
| Fences | | 25.00 | 25.00 |
| Painting Barn | | 50.00 | |
| Painting House | | | 80 60 |
| Water System | | | 75.00 |
| Repair of Irrigation Reservoir | | | 165.00 |
| Work Room and Work Shop | | | 100.00 |
| Cisterns (Gyp water) (are now hauling water) | | 75.00 | 75.00 |
| Seeds and Plants | | 150.00 | 150.00 |
| Fertilizers | | 25.00 | 25.00 |
| Feedstuffs (Cottonseed Meal and Salt) | | 50.00 | 50.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $ 7.00 | | |
| Books as per list | 19.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sampling Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Plate Camera | 75 00 | | |
| Sunshine Recorder | 100 00 | | 335.00 |
| Farm Machinery and Implements: | | | |
| Miscellaneous Implements and Tools | | 50.00 | 50.00 |
| Wagon Bed | | 15.00 | |
| One-Horse Wagon | | | 50.00 |
| Spaulding Deep Tillage Plow | | 150.00 | |
| Sulky Plow | | 55.00 | |
| Harrow | | 15 00 | |
| Planter | | 50.00 | |
| Cultivator | | 35.00 | |
| Spraying Tools | | 25.00 | |
| Gin | | | 100.00 |
| Grain Cradle | | 3.00 | |
| Wagon Scale | | | 90.00 |
| Grain Binder | | | 125.00 |
| One-Row Cultivator | | | 25.00 |
| Blacksmith Outfit | | | 50.00 |
| Live Stock | | .00 | .00 |
| Purchase of Land | | .00 | .00 |
| Miscellaneous Supplies, General | | 50.00 | 50.00 |
| Stakes | | 51.00 | 36 00 |

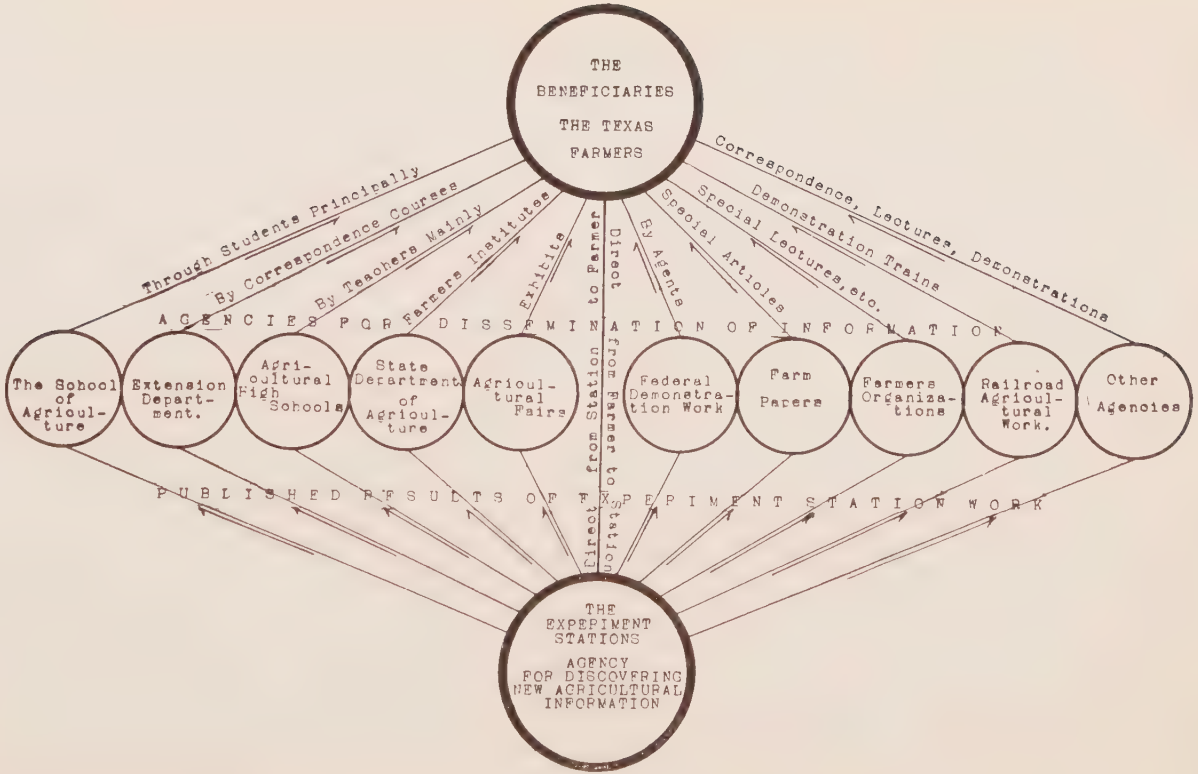
| | | |
|---|---|---|
| Harness | 40.00 | 20.00 |
| Orchard Heaters, Oil for Same, Spray | 35.00 | 20.00 |
| Shock Covers | 50.00 | 50.00 |
| Emergency on Hand for Well and Mill Repairs | 10.00 | 10.00 |
| Surplus | 100.00 | 100.00 |
| Total | $6,000.00 | $6,000 00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 8, LUBBOCK | $6,000.00 | $6,000.00 |
| **ESTIMATE.** | | |
| Salary of Superintendent, Trained Investigator | $1,620.00 | $1,620 00 |
| Skilled Labor | 600.00 | 600.00 |
| Unskilled Laborers, @ $426 00 per year | 1,700 00 | 1,700.00 |
| Furniture and Fixtures, Office (Has None) | | |
| Desk, Chairs, Filing Case, Book Case | 111.00 | 10.00 |
| Office Supplies | 60.00 | 60.00 |
| Freight and Express | 100.00 | 100.00 |
| Traveling Expenses | 100.00 | 125.00 |
| Repairs and Buildings: | | |
| Miscellaneous | 50.00 | 50.00 |
| Fences | 75.00 | 38 00 |
| Double the Implement Shed | 200 00 | |
| Repairs on Tenant Houses | 55 00 | 150.00 |
| New Tenant House | | 400.00 |
| Office Building, Seed Room | 400.00 | |
| Vegetable Covers | | 40.00 |
| Seeds and Plants | 150 00 | 150.00 |
| Fertilizers | 25.00 | 25.00 |
| Feedstuffs (Cottonseed Meal and Salt) | 100.00 | *100.00 |
| Scientific Apparatus: | | |
| Drawing Instruments $ 7.00 | | |
| Books as per list 19.00 | | |
| Thermometer (Tank and Soil) 22.00 | | |
| Bell Jars 5.00 | | |
| Pocket Meter 2.50 | | |
| Farm Level and Sight 10.00 | | |
| Graduate and Beakers 5.00 | | |
| Calipers 2.50 | | |
| Tortion Balances 35.00 | | |
| Grain Testers 18.00 | | |
| Grain Pans 6.00 | | |
| Small Hand Gin (single stalk cotton) 15.00 | | |
| Single Head Thresher 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars 10.00 | | |
| Seed Bottles 10.00 | | |
| Seed Sampling Tubes 5.00 | | |
| Herbarium Paper and Press 10.00 | | |
| Books as per list 25.00 | | |
| Wind Recording Instrument 50.00 | | |
| Seed Germinator 50.00 | | |
| Plate Camera 75.00 | | |
| Sunshine Recorder 100.00 | | 335.00 |

| | | |
|---|---|---|
| Farm Machinery and Implements: | | |
| Miscellaneous Small Tools | 50.00 | 50.00 |
| Cultivator | | 35.00 |
| Hay Press | | 150.00 |
| Lister, Special for Planting | 50.00 | |
| Spraying Outfit | 25.00 | |
| Live Stock | .00 | .00 |
| Purchase Land | .00 | .00 |
| Miscellaneous Supplies | 50.00 | 10.00 |
| Stakes | 37.00 | 37.00 |
| Shock Covers | 50.00 | 50.00 |
| Sprays, Etc. | 25.00 | 25.00 |
| Harness | 40.00 | 40.00 |
| Surplus | 100.00 | 100.00 |
| Total | $6,000.00 | $6,000.00 |

*Not enough pasture.

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 9, PECOS | $6,000.00 | $6,000.00 |
| ESTIMATE. | | |
| Salary of Superintendent, Trained Investigator | 1,500.00 | 1,500.00 |
| Skilled Labor | 600.00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | 1,450.00 | 1,550.00 |
| Office Furniture (Has none now), Desk, Chairs, Record and Filing Case, Book Case | 110.00 | 10.00 |
| Office Supplies | 60.00 | 60.00 |
| Freight and Express | 100.00 | 100.00 |
| Traveling Expenses | 200.00 | 200.00 |
| Repairs and Buildings: | | |
| Necessary Renewal of Engine House | | 297.00 |
| Office and Seed Room and Seed Work Room | 400.00 | |
| Painting all Buildings | | 100.00 |
| Miscellaneous Repairs | 50.00 | 50.00 |
| Addition to Dwelling, Repairs, Etc. | | 100.00 |
| Seeds and Plants | 150.00 | 150.00 |
| Fertilizers | 100.00 | 100.00 |
| Feedstuffs (Cottonseed Meal, Salt and Grain) | 100.00 | 100.00 |
| Machinery and Implements: | | |
| Cotton Gin | 100.00 | |
| Furrowing Plow (Irrigation) | 35.00 | |
| Sulky Plow | | 55.00 |
| Plow | | 18.00 |
| Spray Outfit | 25.00 | |
| Fanning Mill | 35.00 | |
| Miscellaneous Small Tools | 50.00 | 50.00 |
| Small Cultivator | | 25.00 |
| Live Stock | .00 | .00 |
| Purchase Land | .00 | .00 |
| Miscellaneous Supplies | 50.00 | 50.00 |
| Spray Material | 20.00 | 15.00 |
| Oils and Engine Fuel | 275.00 | 300.00 |
| Shock Covers | 50.00 | 50.00 |
| Harness | 40.00 | 20.00 |




This diagram shows the relation between the experiment station system and the Texas farmer. For lack of space not all the functions of the disseminating agencies are shown.

| | | |
|---|---|---|
| Irrigation Tile and Installation | 400.00 | 400.00 |
| Surplus | 100.00 | 100.00 |
| Total | $6,000.00 | $6,000 00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 10 (FEEDING AND BREEDING SUBSTATION), COLLEGE STATION | $6,000.00 | $6,000.00 |
| ESTIMATE. | | |
| Salary of Superintendent, Trained Investigator | 1,500.00 | 1,500.00 |
| Labor, Skilled and Unskilled | 2,500.00 | 2,500.00 |
| Office Furniture and Fixtures, File and Book Case | 55.00 | 10.00 |
| Office Supplies | 30.00 | 30.00 |
| Freight and Express | 200.00 | *200.00 |
| Repairs and Buildings: | | |
| One Tenant House | 265.00 | 250.00 |
| Fences | 75.00 | 75.00 |
| Miscellaneous | 115.00 | 75.00 |
| Seeds and Plants, Decorative Plants $10 00, Farm Seeds $200.00 | 210.00 | 210.00 |
| Fertilizers | 600.00 | **400.00 |
| Feedstuffs, Cottonseed Meal and Salt, for Horses Only | 100.00 | 100.00 |
| Scientific Apparatus | 10.00 | 30.00 |
| Farm Machinery: | | |
| Mower | 45.00 | |
| Miscellaneous | 75.00 | 75.00 |
| Row Binder | | 135.00 |
| Disc Harrow | 35.00 | 35 00 |
| Live Stock | .00 | .00 |
| Purchase Land | .00 | .00 |
| Miscellaneous Supplies: | | |
| Dip | 50 00 | 50.00 |
| Harness | 40.00 | 65.00 |
| Water Supply | | 160.00 |
| Surplus | 95.00 | 100.00 |
| Total | $6,000.00 | $6,000.00 |

*Additional Freight and Express can be paid for from special projects.
**Cut down cottonseed meal fertilizers and third year use phosphate only, not over 200 pounds to the acre—use manure

| | 1915-16. | 1916-17. |
|---|---|---|
| SUBSTATION NO. 11, NACOGDOCHES | $6,000.00 | $6,000.00 |
| ESTIMATE. | | |
| Salary of Superintendent, Trained Investigator | $1,680.00 | $1,680.00 |
| Skilled Labor | 600 00 | 600.00 |
| Unskilled Laborers, @ $426.00 per year | 1,704.00 | 1,704 00 |
| Office Furniture and Fixtures, Record and File Case, Book Case | 55.00 | 10.00 |
| Office Supplies | 60 00 | 60.00 |
| Freight and Express | 50 00 | 50.00 |
| Traveling Expenses | 100.00 | 100.00 |
| Repairs and Buildings: | | |
| Tenant House | 179.00 | |

| | | | |
|---|---|---|---|
| Miscellaneous Repairs | | 50.00 | 50.00 |
| Fences | | 25.00 | 25.00 |
| Addition to Tool Shed | | 150.00 | |
| Painting | | 50.00 | 75.00 |
| Chicken House and Runs | | | 20.00 |
| Hot House and Beds | | | 75.00 |
| Seeds and Plants | | 150.00 | 150.00 |
| Fertilizers | | 200.00 | 200.00 |
| Feedstuffs (Cottonseed Meal and Salt, Etc.) | | 200.00 | 200.00 |
| Scientific Apparatus: | | | |
| Drawing Instruments | $7.00 | | |
| Books as per list | 19.00 | | |
| Thermometer (Tank and Soil) | 22.00 | | |
| Bell Jars | 5.00 | | |
| Pocket Meter | 2.50 | | |
| Farm Level and Sight | 10.00 | | |
| Graduate and Beakers | 5.00 | | |
| Calipers | 2.50 | | |
| Tortion Balances | 35.00 | | |
| Grain Testers | 18.00 | | |
| Grain Pans | 6.00 | | |
| Small Hand Gin (single stalk cotton) | 15.00 | | |
| Single Head Thresher | 5.00 | | |
| Soil Cans, Asbestos Ovens, Tubes, Augers | 75.00 | 227.00 | |
| Seed Magnifying and Examining Jars | 10.00 | | |
| Seed Bottles | 10.00 | | |
| Seed Sapping Tubes | 5.00 | | |
| Herbarium Paper and Press | 10.00 | | |
| Books as per list | 25.00 | | |
| Wind Recording Instrument | 50.00 | | |
| Seed Germinator | 50.00 | | |
| Plate Camera | 75 00 | | |
| Sunshine Recorder | 100.00 | | 335.00 |
| Farm Machinery and Implements: | | | |
| Plow | | 50.00 | |
| Miscellaneous | | 50.00 | 50.00 |
| Forge and Shop Tools | | | 75.00 |
| Hay Press | | | 150.00 |
| Cultivator | | 35.00 | |
| Pea Huller | | 35.00 | |
| Fanning Mill | | 35.00 | |
| Ditching Plow | | 25.00 | |
| Spray Outfit | | 50.00 | |
| Live Stock | | .00 | .00 |
| Purchase Land | | .00 | .00 |
| Miscellaneous Supplies: | | | |
| Sprays | | 25.00 | 25.00 |
| Shock Covers | | 50 00 | 50.00 |
| Orchard Heaters, Etc | | 50.00 | 26.00 |
| Harness | | 20.00 | 20.00 |
| Horse Shoes | | 20.00 | 20.00 |
| Tile Drains | | 100.00 | 300.00 |
| Surplus | | 100.00 | 100.00 |
| Total | | $6,000.00 | $6,000.00 |

| | 1915-16. | 1916-17. |
|---|---|---|
| CHILLICOTHE STATION | $6,000.00 | $6,000.00 |
| ESTIMATE. | | |
| One-Half Salary of Superintendent | | 750.00 |
| Skilled Labor | | 600.00 |
| Unskilled Laborers, @ $426.00 per year | | 1,320.00 |
| Office Furniture | | 10.00 |
| Office Supplies | | 30.00 |
| Freight and Express | | 100.00 |
| Traveling Expenses | | 75.00 |
| Repairs and Buildings: | | |
| Miscellaneous Repairs | | 50.00 |
| Tenant Houses | | 400.00 |
| Fences | | 100.00 |
| Barn | | 750.00 |
| Tool Shed | | 400.00 |
| Seeds and Plants | | 50.00 |
| Fertilizers | | 25.00 |
| Feedstuffs (Cottonseed Meal and Salt) | | 50.00 |
| Scientific Apparatus: | | |
| Drawing Instruments $7.00 | | |
| Books as per list 19.00 | | |
| Thermometer (Tank and Soil) 22.00 | | |
| Bell Jars 5.00 | | |
| Pocket Meter 2.50 | | |
| Graduate and Beakers 5.00 | | |
| Farm Level and Sight 10.00 | | |
| Calipers 2.50 | | |
| Tortion Balances 35.00 | | |
| Grain Testers 18.00 | | |
| Grain Pans 6.00 | | |
| Small Hand Gin (single stalk cotton) 15.00 | | |
| Single Head Thresher 5.00 | | |
| Seed Magnifying and Examining Jars 10.00 | | |
| Seed Bottles 10.00 | | |
| Seed Sampling Tubes 5.00 | | |
| Herbarium Paper and Press 10.00 | | |
| Books as per list 25.00 | | |
| Wind Recording Instrument 50.00 | | |
| Seed Germinator 50.00 | | |
| Plate Camera 75 00 | | |
| Sunshine Recorder 100.00 | | 487.00 |
| Farm Machinery and Implements: | | |
| Miscellaneous | | 50 00 |
| Disc Harrow | | 35.00 |
| Cotton Gin | | 100.00 |
| Plows (2) | | 70.00 |
| Spraying Tools | | 20.00 |
| Gas Engine | | 300.00 |
| Live Stock | | .00 |
| Purchase Land | 6.000.00 | |
| Harness | | 60.00 |

| | | |
|---|---|---|
| Spray Material | | 18.00 |
| Shock Covers | | 50.00 |
| Surplus | | 100.00 |
| Total | $6,000.00 | $6,000.00 |

| | 1915-16 | 1916-17 |
|---|---|---|
| FEEDING AND BREEDING INVESTIGATIONS. | $20,000.00 | $20,000.00 |

**Explanation:**

| | | |
|---|---|---|
| Steer feeding experiments | 5,000.00 | 5,000.00 |
| Dairy feeding and breeding investigations | 3,000.00 | 3,000.00 |
| Poultry feeding and breeding investigations | 2,500.00 | 2,500.00 |
| Sheep feeding and breeding investigations | 3,000.00 | 3,000.00 |
| Swine feeding and breeding investigations | 4,000.00 | 4,000.00 |
| Goat breeding and improvement investigations | 2,500.00 | 2,500.00 |
| | $20,000.00 | $20,000.00 |

| | 1915-16 | 1916-17 |
|---|---|---|
| PUBLICATION OF BULLETINS, ETC. | $7,500.00 | $7,500.00 |

**Explanation:**

Publication of Station bulletins, circulars, and so forth.

## RECAPITULATION.

| | |
|---|---|
| Total annual appropriation requested for Main Station | $ 47,000.00 |
| Total annual appropriation requested for substations | 101,000.00 |
| Total annual appropriation requested | $148,000.00 |
| Main Station for biennum | $ 94,000.00 |
| Substations for biennum | 202,000.00 |
| Total for biennum | $296,000.00 |

Each item requested in these estimates represents a specific need of the Station system. No funds are being asked for new work, except as specifically stated. We have asked only for what is actually necessary in order to use our present force of men and equipment in the most efficient manner. In fact, not everything needed is asked for; otherwise these estimates would be greatly increased.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR No. 6, NEW SERIES MARCH, 1915

DIVISION OF FEED CONTROL SERVICE

# HOW TO COMPLY WITH THE LAW REGULATING THE SALE OF CONCENTRATED FEED STUFFS IN TEXAS

## OTHER INFORMATION

POSTOFFICE:
College Station, Brazos County, Texas

VON BOECKMANN-JONES CO., PRINTERS, AUSTIN, TEXAS
1915

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## OTHER INFORMATION

By

B. YOUNGBLOOD, Director.

POSTOFFICE:

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# HOW TO COMPLY WITH THE LAW.

## OTHER INFORMATION.

BY B. YOUNGBLOOD, DIRECTOR.

The Twenty-ninth Legislature of the State of Texas passed an act—

(1) Regulating the sale of concentrated commercial feeding stuffs and the material from which they are manufactured.

(2) Defining them.

(3) Prohibiting their adulteration.

(4) Providing for their correct weighing and marking.

(5) Providing for the collection of samples.

(6) Providing for the expenses of enforcing the law.

(7) Fixing penalties for violatins, and

(8) Empowering the Director of the Experiment Station (a) to adopt standards, names and definitions; (b) to refuse registration of any feeding stuff under a name which would be misleading as to the materials of which it is made up, or which does not conform to the standards, names and definitions aforesaid, and (c) after ten days notice to cancel such registration as may, from time to time, be found to be in violation of the law or the names, standards and definitions adopted by the Director of the Experiment Station in accordance with this law.

The law is printed in this bulletin.

*The Purpose of the Feed Control Service.*—The purpose of the Feed Control Service is to afford protection alike to the sellers and the buyers of concentrated commercial feeding stuffs in the State of Texas. This end is attained by the Feed Control Service by

(I) Requiring that no feeding stuff shall be sold under a name that is in the least misleading. This means that no person or corporation shall sell a *mixture* for a *pure product*. For instance, it is a violation of the law to sell a mixture of cotton seed meal and hulls under the name of "Cotton Seed Meal," when obviously the correct definition is "Cotton Seed Meal and Hulls."

(II) Requiring that the correct analysis of each and every feeding stuff sold within the State *shall be printed—not stamped—on the inspection tag.* By a comparison of the constituents, analysis and the price of a given feeding stuff with those of another, the buyer is enabled to determine for himself which feeding stuff is the cheapest and the best suited for his particular purpose. If he should have any difficulty in this regard he should write the Feed Control Service for additional information.

The seller of feeding stuffs is protected by the development of uniform standards which eliminate unfair competition. He is expected to comply with the law, not merely for the sake of compliance, but because in the long run it is the wiser course. The seller who habitually complies with

the law has the confidence of the feeders and the public generally and avoids the unnecessary expense and the unsavory reputation incident to prosecution for violations.

*What the Term Includes.*—The term "concentrated commercial feeding stuff," as herein used, shall include wheat bran, wheat shorts, linseed meal, cotton seed meal, cotton seed cake, peanut cake, cocoanut meal, gluten meal, gluten feeds, sugar feeds, dried brewers' grains, malt sprouts, hominy feeds, cerealine feeds, rice bran, rice polish, oat feeds, corn chops, ground beef, kafir feed, alfalfa meal, corn feed meal, rolled oats, cold pressed cotton seed, ground cold pressed cotton seed, rice hulls, corn bran, blood meal, digester tankage, cracklings, meat scrap, meat meal, meat and bone scrap, meat and bone meal, buckwheat shorts, corn germ meal, flax plant by-products, oat groats, oat middlings, poultry feed, oat shorts, mixed feeds, and all other materials of a similar nature.

*What is not Included.*—The term "concentrated commercial feeding stuff," as herein used, *shall not include* hay, straw, the whole seeds of grains of wheat, barley, rye, oats, Indian corn, rice, buckwheat or broom corn, or any other whole or unground grains or seeds. However, should there be added to hay, straw, whole or unground grains or seeds, any cracked grains or seeds which come under concentrated commercial feeding stuffs, the whole would then be treated as a concentrated commercial feeding stuff, and subject to the requirements of the law.

*Adulterants.*—The following ingredients are classed as adulterants: corn bran, screenings, rice hulls, peanut hulls, chaff, oat hulls, oat meal by-products, ground corn cobs, ground alfalfa, ground hay, sawdust, dirt, damaged feed, or any similar substance.

*How to Comply with the Law.*—Briefly summarized, the law requires manufacturers and importers of concentrated commercial feeding stuffs, or the party or parties who cause them to be sold or offered or exposed for sale, to comply with the following requirements:

*All Concentrated Commercial Feeding Stuffs Must Be Registered.*—Any person, manufacturer, importer or agent desiring to sell or offer for sale within this State any concentrated commercial feeding stuff shall submit a sample of the feeding stuff to be registered, of at least one pound for analysis. This sample should be shipped prepaid either by parcel post or express, in a sealed glass jar or bottle. The sample must be a fair average of the feeding stuff to be registered. Upon receipt of this sample, registration forms will be furnished. If, upon analysis, the feeding stuff is found to conform with the required names, definitions and standards and otherwise complies with the intent of the law, the feeding stuff will be registered.

*Concentrated Commercial Feeding Stuffs Must Be Tagged.*—After a feeding stuff is registered the person, manufacturer, agent or importer is notified that he may offer it for sale, provided he attaches the official tax tag as required by law. These tags, each good for 100 pounds net, are purchased from the Feed Control Service. All tags are sold at such a price as will make the inspection tax 10 cents per ton on all con-

centrated commercial feeding stuffs sold or offered for sale within the State of Texas. One tag should be attached to each bag, barrel or other package of feeding stuff sold or offered for sale.

*Weights.*—The law fixes the standard weights for feeding stuffs as follows:

Mill products have the following standard weights, viz.: Flour, one-hundred and ninety-six (196) pounds per barrel or forty-eight (48) pounds per sack. Corn meal, bolted or unbolted, thirty-five (35) pounds per sack; rice bran, one hundred and forty-three (143) pounds per sack; rice polish, two hundred (200) pounds per sack; and other feeding stuffs made from cereals of any kind, whether pure, mixed or adulterated, one hundred (100) pounds per sack. Fractional barrels, sacks or packages, shall weigh in the same proportion, as, one-sixteenth, one-eighth, one-fourth, one-half, and three-fourths. Sacks and barrels of odd weights, as for instance, 93 or 90 pounds, are not contemplated in the feed law and tax tags for such odd weights as these are not carried in stock by the Feed Control Service.

*Bulk Sales.*—It shall be the duty of the manufacturer or importer or agent in the sale and shipment of concentrated commercial feeding stuffs in bulk, to furnish the purchaser with tags to cover, at the regular tonnage rate of twenty tags per ton. For instance, if Cotton Oil Co., manufacturers, or Jones & Co., importers, sell to Roberts & Son, ranchmen, Odessa, Texas, a carload of loose cake, it will be the duty of Cotton Oil Co. or Jones & Co. to transmit to Roberts & Son tags sufficient to cover the shipment. In the event that Roberts & Son fail to receive these tags simultaneously with the shipment it will be their duty to immediately notify the Feed Control Service. A complete record of such sales, with number of tags furnished, should at all times be kept by manufacturers, agents or importers, for the information of the Feed Control Service.

*Enforcement of the Law.*—Enforcement of the feeding stuff law is a matter of protection to the feeder against adulteration with low grade feeding stuffs, and affords protection to honest dealers and manufacturers of feeding stuffs against dishonest competition. When a feeding stuff is adulterated it is by means of the introduction of cheaper or low grade materials. There is a tendency on the part of some manufacturers to lower the feeding value of feeding stuffs, for the purpose of reducing the price of a given product. Feed inspectors travel continuously throughout the year, visiting all sections of the State, examining feeding stuffs for adulteration, false weights, untagged goods, and other violations; collecting information concerning feeding stuffs, giving information to the farmer, feeder and miller, and taking samples of feeding stuffs offered for sale. The samples collected are forwarded to the Feed Control Service, at College Station, and submitted to the State Chemist, who is chemist to the Feed Control Service. They are then submitted to physical and chemical analysis. If physical anlysis shows the presence of adulterants the manufacturer or importer is notified that registration is cancelled, and he is no longer permitted to offer this product for sale until properly registered and tagged. Prosecution often follows.

Inspection samples are analyzed in the order in which they are received in the office, the purpose of analyses being to verify the guarantees made by the manufacturers and to see that they maintain the standard adopted for such feeding stuffs.

*Complaints:* Upon receiving a complaint that the feed law is being violated a thorough investigation is made, often necessitating sending an inspector to see the complainant. The inspector gathers evidence, reports fully to headquarters, and such action is then taken as will give justice to both miller and consumer.

*What has Been Accomplished.*—Some of the results of the feed law are as follows:

(1) It has placed the feeding stuff trade on such a basis that mixtures of corn chops, wheat bran, wheat shorts, cotton seed meal, and other products with corn bran, screenage, sweepings, cotton seed hulls and such materials, are now sold *for what they really are,* and not as pure corn chops, wheat bran, cotton seed meal, and so forth.

(2) It has equalized and promoted uniformity in the selling price of feeding stuffs.

(3) It has induced farmers and feeders to investigate the relative values of feeding stuffs and has thus increased the sale of feeding stuffs of known value.

(4) It has prevented the sale of a number of worthless feeding stuffs.

(5) It has encouraged the manufacturers to maintain a high standard.

(6) It has prevented the shipment into the State of inferior feeding stuffs, barred from other States that have feeding stuffs laws.

(7) It has prevented the sale of adulterated feeds as pure products.

*Co-operation with the United States Department of Agriculture.*—On March 9, 1912, the Director received a commission from the United States Department of Agriculture to collect samples of feeding stuffs and other products as defined in the Texas feeding stuffs law, which are manufactured or offered for sale in the District of Columbia or in any State or Territory of the United States, or which shall be offered for sale in unbroken packages in any State other than that in which they shall have been respectively manufactured or purchased, for examination under the direction or supervision of the Bureau of Chemistry, at Washington, D. C.

By means of this appointment the Director of the Experiment Station and his assistants are authorized to procure samples under the Federal Food and Drugs Act without the necessity of waiting, as previously, for the services of a Federal inspector, and by this commission we are in a much better position to control interstate shipments and protect the purchaser who buys feeding stuffs manufactured outside of the State of Texas.

*Relation to the Experiment Station.*—The Texas Agricultural Experiment Station is carrying on investigations of the chemical composition, digestibility and nutritive values of feeding stuffs. It is also conducting feeding experiments at College Station, and at other points in the State.

The Feed Control Service, therefore, is in the position to secure expert advice and assistance with respect to various problems arising under the operation of the law. The Veterinary Division of the Experiment Station, for example, has tested various feeding stuffs suspected of having caused the death of live stock by poisoning. The Division of Chemistry has made a study of the moisture in corn chops as related to the spoiling of this product—a matter which has caused great losses during years past, especially during the spring of 1912. The Division of Chemistry has also investigated and still has under investigation, various methods for the examination of feeding stuffs with respect to adulteration. The connection with the Experiment Station is thus of advantage both to the Feed Control Service and to the Experiment Station. The Feed Control Service brings various problems to the attention of the Experiment Station which require solution.

Bulletins of the Feed Control Service are sent out by the Experiment Station from time to time. These publications are sent free upon application.

*Educational Value of Feed Control Service.*—When the feed law first went into effect in Texas most of the millers knew very little of the composition of feeding stuffs. Analyses were made for the purpose of complying with the law by chemists who had little knowledge of feeding stuffs, whatever their qualifications. The results of some of these analyses were very surprising indeed. The Feed Control Service thus had, in the beginning, considerable educational work to do among the manufacturers, supplying them with various information in regard to the law and the composition and nature of feeding stuffs. Many millers were not permitted to make guarantees which they could not possibly maintain. At the present time the manufacturers have become more or less familiar with the law, the chemical analyses of feeding stuffs and their significance, but there is much educational work to be done among the feeders. The Feed Control Service, therefore, includes in its bulletins information concerning the protein, fat and other constituents of feeding stuffs, and other information concerning the nature and value of the various feeding stuffs, and endeavors to circulate its bulletins as widely as possible among the farmers and feeders of the State, so that they may have information concerning feeding stuffs in general, and the specific feeding stuffs in particular available in various markets of the State.

*Standards and Definitions.*—The law empowers the Director of the Experiment Station to adopt names, standards and definitions for feeding stuffs. He may refuse the registration of any feeding stuff under a name which would be misleading as to the materials of which it is made, or which does not conform to the standards and definitions adopted. If a feeding stuff is registered and then discovered to be in violation of the standards and definitions adopted, the director has the power to cancel registration after ten days notice.

## COPY OF LAW REGULATING SALE OF FEED STUFFS IN THE STATE OF TEXAS.

(EFFECTIVE JULY 11, 1907.)

An Act to amend Sections 1, 4, 5, 6 and 11, of Chapter 108, Acts of the Twenty-ninth Legislature, being an act entitled "An Act regulating the sale of concentrated commercial feeding stuffs and the materials from which they are manufactured, defining concentrated feeding stuffs, prohibiting their adulteration, providing for their correct weighing and marking, and providing for the collection of samples, the expenses of the enforcement of the law, and fixing penalties for its violation," and to add thereto:

"SEC. 11A. Empowering the director of the Experiment Station to adopt standards and definitions for concentrated feeding stuffs and to refuse the registration of feeding stuff under certain circumstances, and to cancel registration under certain circumstances after notice, and to empower said director to adopt rules and regulations for the enforcement of all of the provisions of this act."

*Be it enacted by the Legislature of the State of Texas:*

SECTION 1. That Sections 1, 4, 5, 6 and 11, of Chapter 108, of the Twenty-ninth Legislature, entitled "An Act regulating the sale of concentrated commercial feeding stuffs and the materials from which they are manufactured, defining concentrated feeding stuffs, prohibiting their adulteration, providing for their correct weighing and marking and providing for the collection of samples, the expenses of the enforcement of the law and fixing penalties for its violation," be so amended as to hereafter read as follows, and that

Section 11A, empowering the director of the Experiment Station to adopt standards and definitions for concentrated feeding stuffs and to refuse the registration of feeding stuffs under certain circumstances and to cancel registration under certain circumstances after notice, and to empower said director to adopt rules and regulations for the enforcement of all the provisions of this act, be enacted so as to read as follows:

"Section 1. Every lot or parcel of concentrated feeding stuffs, as defined in Section 3 of this act, used for feeding farm live stock, sold, offered or exposed for sale in the State of Texas for use within this State, shall have printed on a tax tag, described in Section 5 of this act, a plainly printed statement clearly and truly certifying the number of net pounds of feeding stuff in the package, stating the name or names of materials of which such weight is composed where the contents are of a mixed nature, the name, brand or trade-mark under which the article is sold, the name and the address of the manufacturer or importer, the place of manufacture, such information as is required by Section 11, if any, and a chemical analysis stating the minimum percentages it contains of crude protein, allowing 1 per cent of nitrogen to equal 6¼ per cent of protein, of crude fat, of nitrogen-free extract, and the maximum percentage it contains of crude fiber; these con-

stituents to be determined by the methods adopted at the time by the Association of Official Agricultural Chemists of the United States. Mill products hereinafter mentioned shall have the following standard weights, viz.: Flour, one hundred and ninety six (196) pounds per barrel, or forty-eight (48) pounds per sack; corn meal, bolted or unbolted, thirty-five (35) pounds per sack; rice bran, one hundred and forty-three (143) pounds per sack; rice polish, two hundred (200) pounds per sack; and other feeds made from cereals of any kind, whether pure, mixed, or adulterated, one hundred (100) pounds per sack. Fractional barrels and sacks shall weigh in the same proportion, and these weights shall be net and exclusive of the barrel or sack in which said product is packed. Any person, firm or association of persons engaged in the manufacture of mill products of any character whatsoever, who shall use any bag, box, barrel or any other receptacle into which to put such product other than one bearing the name of such mill manufacturing the same, shall be guilty of a misdemeanor, and upon conviction therefor shall be fined in any sum from one hundred dollars to one thousand dollars, or in addition thereto be confined in the county jail for a term of thirty days, or both such fine and imprisonment."

Sec. 2. The term concentrated commercial feeding stuffs, as herein used, shall not include hay and straw, the whole seed or grains of wheat, barley, rye, oats, Indian corn, rice, buckwheat or broom corn, or any other whole or unground grains or seeds.

Sec. 3. The term concentrated feedstuffs, as herein used, shall include wheat bran, wheat shorts, linseed meals, cottonseed meals, pea meals, cocoanut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewer's grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, rice bran, rice polish, rice hulls, oat feeds, corn and oat chops, corn chops, ground beef, or mixed fish feeds, and all other materials of similar nature not included in Section 3 of this act.

Sec. 4. Before any concentrated feeding stuff, as defined in Section 3 of this act, is so offered or exposed for sale, the importer, manufacturer, and party who causes it to be sold or offered for sale within the State of Texas for use within this State shall, for each and every feedstuff bearing a distinguishing name and trade-mark, file with the director of the Texas Agricultural Experiment Station a certified copy of the statement named in Section 1 of this act, and shall also deposit with said director a sealed glass jar or bottle containing not less than one pound of the feeding stuff to be sold or offered for sale, accompanied by an affidavit that it is a fair average sample thereof and corresponds within reasonable limits to the feeding stuff which it represents in the percentage of protein, fat and crude fiber and nitrogen-free extract which it contains. This shall not be construed to apply to farmers who grind their own feedstuff and who do not adulterate same.

Sec. 5. The manufacturer, importer, agent or seller of each concentrated commercial feeding stuff, as defined in Section 3 of this act, shall, before the article is offered for sale, pay to the director of the Texas Agricultural Experiment Station an inspection tax of ten cents per ton for each ton of such concentrated feeding stuff sold or offered for sale in the State of Texas for use within this State, and shall affix

to each lot shipped in bulk, and to each bag, barrel or other package of such concentrated feeding stuffs a tag to be furnished by said director stating that all charges specified in said section have been paid. The director of said Texas Agricultural Experiment Station is hereby empowered to prescribe the form of such tags and adopt such regulations as may be necessary for the enforcement of this law. Whenever the manufacturer, or importer or shipper of a concentrated feeding stuff shall have filed a statement made in Section 1 of this act, and have paid the inspection tax, no agent or seller of said manufacturer, importer or shipper, shall be required to file such statement or pay such tax. The amount of the inspection tax and penalties received by said director shall be paid into the State Treasury. So much of the inspection tax and penalties collected under this act shall be paid by the State Treasurer to the Treasurer of the Texas Agricultural and Mechanical College as the director of the Texas Agricultural Experiment Station may show by his bills has been expended in performing the duties required by this act, but in no case to exceed the amount of the inspection tax and penalties received by the State Treasurer under this act. Provided the excess, if any, for the next two years may be used as it accrues by the Board of Directors of the Agricultural and Mechanical College for the purpose of putting up a station administration building to provide the necessary offices and laboratory space, in order that the purposes of this act may be carried out.

SEC. 6. Any manufacturer, importer or agent selling, offering or exposing for sale any concentrated commercial feeding stuff as defined in Section 3 of this act, without the statement required by Section 1 and the tax tag required by Section 5 of this act, or with a label stating that said feeding stuff contains substantially a larger percentage of protein, fat or nitrogen-free extract, or a smaller quantity of crude fiber than is contained therein, and any person violating any other provisions of this act shall, on conviction in a court of competent jurisdiction, be fined not less than one hundred dollars nor more than five hundred dollars for the first conviction, and not less than five hundred dollars nor more than one thousand dollars for each subsequent conviction.

SEC. 7. Any person who shall counterfeit or use a counterfeit of the tag or tags prescribed by this act, knowing the same to be counterfeited, or who shall use them a second time after the said tags shall have once been attached, shall be guilty of a misdemeanor, and on conviction thereof shall be fined in a sum not exceeding five hundred dollars, one half of which shall be paid to the informer; which fine may be doubled or tripled at each second or third conviction, and so on progressively for subsequent convictions.

SEC. 8. All manufacturers and importers of concentrated commercial feeding stuffs, or dealers in same, shall, when requested, furnish the director of the Texas Experiment Station with a complete list of names or trade-marks of such feeding stuffs.

SEC. 9. The director of the Texas Agricultural Experiment Station shall cause one analysis or more to be made annually of each concentrated commercial feeding stuff sold or offered for sale under the provisions of this act. Said director is hereby authorized in person, or by deputy, to take a sample not exceeding two pounds in weight for

analysis from any lot or packages of concentrated commercial feeding stuffs which may be in the possession of any manufacturer, importer, agent, dealer or buyer in this State, but said sample shall be drawn or taken in the presence of said party or parties at interest or their representative, and shall be taken from a parcel, lot or number of parcels which shall not be less than 5 per cent of the whole lot inspected, and shall be thoroughly mixed and divided into two samples and placed in glass or metal vessels carefully sealed and label placed on each stating the name or brand of the feeding stuff or material sampled, and the name of the party from whose stock the sample is drawn and the date and place of taking such sample, and said label shall be signed by the director or his deputy and the party or parties at interest or their representatives present at the taking and sealing of said sample; provided, that where the party or parties at interest refuse to be present and take part in the sampling of the said feedstuffs, the director or his deputies may take said samples in the presence of two disinterested witnesses, one of said duplicate samples shall be retained by the director and the other shall be left with the party whose stock was sampled, and the sample or samples retained by the director shall be for comparison with the certified statements made in Sections 1 and 4 of this act. The result of the analysis of the sample or samples so prescribed, together with such additional information as circumstances advise shall be published in reports or bulletins by the Texas Agricultural and Mechanical College from time to time.

Sec. 10. The term importer for all purposes of this act shall be taken to mean all such persons as shall bring into or offer for sale within the State concentrated commercial feeding stuffs manufactured without this State.

Sec. 11. Any person manufacturing, selling or offering for sale any adulterated feeding stuff within this State, shall, upon conviction therefor, be punished by fine of not less than twenty-five dollars and not more than two hundred dollars, or be imprisoned in the county jail for a term of not less than thirty days and not more than sixty days, or by both such fine and imprisonment. For the purpose of this act a feeding stuff shall be deemed to be adulterated if it contains any sawdust, dirt, damaged feed, or any foreign matter whatever, or if it is in any respect not what it is represented to be, or if any rice hulls or chaff, peanut shells, corn cobs, oat hulls, or other similar substances of little or no feeding value are admixed therewith; provided, that no wholesome mixture of feeding stuff shall be deemed to be adulterated if the true percentage of constituents thereof is plainly and clearly stated on the package and made known to the purchaser at the time of the sale. It shall be the duty of the director of the Experiment Station to examine, or have examined for adulteration, all suspicious samples of feeding stuffs and such other samples as may be desirable.

Sec. 11a. The director of the Experiment Station is hereby empowered to adopt standards or definitions for concentrated feeding stuffs and such regulations as may be necessary for the enforcement of the law. The said director shall have the power to refuse the registration of any feeding stuff under a name which would be misleading as to the materials of which it is made up, or which does not conform to the

standards and definitions aforesaid. Should any of said materials be registered and it is afterwards discovered that they are in violation of the above provisions, the said director shall have the power to cancel the registration ten days after notice. The director of the Texas Experiment Station is hereby empowered to adopt such regulations as may be necessary for the enforcement of all the provisions of this act.

SEC. 12. The fact that the present feedstuff law imposes a greater tax than is necessary for the enforcement of the provisions thereof and is indefinite and uncertain in some of its provisions, creates an emergency and an imperative public necessity that the constitutional rule requiring bills to be read on three several days be suspended, and that this act take effect from and after it passage, and it is so enacted.

(NOTE.—This law becomes effective July 11, 1907.)

*Redemption of Tags.*—When tags are printed in error, or if for any reason not in correct form, they will be redeemed by the Feed Control Service at their full value less the original cost of the tags. In sending tags to us for redemption you should make shipment by prepaid express, writing the Feed Control Service at the time you make the shipment, stating the number and denomination of tags you are sending and enclose express receipt.

*Change in Name of Firm.*—When the name of the firm is changed in any way whatever it requires a new registration. A form must be filled out and a new sample sent to the Feed Control Service by prepaid express. Sample must be sent in a sealed glass jar.

*Name of Millrun Bran Changed.*—The term "Millrun Bran" in connection with registering this product is no longer permitted. The term "Wheat Mixed Feed" is now used to designate this product. When filling out registration forms for this product please bear this in mind.

*Name of Milo and Kafir Products Changed.*—Because of the fact that the correct designation of Milo and Kafir products heretofore referred to as "Milo Maize" and "Kafir Corn" are "Milo" and "Kafir," one "f" has been dropped from the word "Kafir," and the words "corn" and "maize" have been omitted from the two names. Manufacturers are requested to conform to these changes in the names of their Kafir and Milo products. Registrations are not permitted to read "Kafir *or* Milo"; they may, however, read "Kafir *and* Milo" and in this instance the feed referred to MUST contain both products.

The following information is required to be printed on the reverse side of tax tags, by the person, agent, dealer, manufacturer or importer. Under no circumstances will the Feed Control Service print this information on the tags:

(1) Number of net pounds of feeding stuff the package contains.

(2) Name of feeding stuff, exactly as shown in registration.

(3) Names of material of which such feed is composed, where the contents are of a mixed nature.

(4) Percentage of ingredients where corn cobs, corn bran, rice hulls, or any other adulterant, is present.

(5) Name and address of manufacturer or importer and place of manufacture.

(6) Guaranteed analysis, stating the minimum percentages of crude protein, crude fat, nitrogen-free extract, and the maximum percentage of crude fiber, in the feeding stuff, exactly as shown in registration.

Attention is called to the fact that all information on the tax tag must be *printed. The use of rubber stamp for this purpose is not permitted.*

We suggest that the foregoing information be PRINTED on the reverse side of the tag in the following form:

100 Pounds (Net) Pure Corn Chops

Manufactured by

JOHN DOE MILLING COMPANY

Doeville, Texas.

---

GUARANTEED ANALYSIS.

| | |
|---|---|
| Protein not less than | 9.00 per cent. |
| Fat not less than | 3.50 per cent. |
| Nitrogen—free Extract not less than | .70 per cent. |
| Crude Fiber not MORE than | 3.00 per cent. |

*Safe Guarantee for a Feed.*—The following table shows a safe guarantee which may be used in registering feedstuffs with the Feed Control Service. The guarantees suggested below are based on actual analyses made by our Chemist during the last three years and should be used by manufacturers in registering a given feed.

*Safe Guarantee for a Mixed Feed.*—In order to arrive at a safe guarantee for a mixed feed it is necessary that the percentage of each ingredient be known. For instance, a mixed feed is composed of fifty per cent Corn Chops and fifty per cent Wheat Bran. The percentage of Protein in Corn Chops is 9.00; thus fifty per cent of this feed would be 4.50, and the percentage of Protein in Wheat Bran is 14.50; thus fifty per cent of this feed would be 7.25, therefore the percentage of Protein in the mixed feed would be 4.50 plus 7.25 or 11.75. This method may be continued throughout to find the different percentages for each content. In case more than two feeds enter into the mixture the same procedure may be used in ascertaining a safe guarantee, only, of course, using the exact percentage of the different ingredients each time instead of fifty per cent as above.

SAFE GUARANTEES WHICH MAY BE USED IN REGISTERING.

| Name of Feedstuff. | Crude protein not less than per cent. | Crude fat not less than per cent. | Nitrogen-free extract not less than per cent. | Crude fiber not more than per cent. |
|---|---|---|---|---|
| Alfalfa meal | 13.50 | 1.50 | 37.00 | 30.00 |
| Barley chops | 11.00 | 1.50 | 64.00 | 6.00 |
| Beet molasses | 9.00 | ..... | 59.00 | ..... |
| Beet pulp | 0.75 | ..... | 6.00 | 2.50 |
| Blood, dried | 84.00 | 2.50 | ..... | ..... |
| Brewers' grains, dried | 24.00 | 6.00 | 40.00 | 18.00 |
| Caneseed chops | 9.00 | 3.00 | 70.00 | 3.00 |
| Chaff | 3.00 | 0.50 | ..... | 36.00 |
| Corn bran | 9.00 | 5.00 | 63.00 | 10.50 |
| Corn, broom, seed | 10.00 | 3.00 | 63.00 | 7.50 |
| Corn chops | 9.00 | 3.50 | 70.00 | 3.00 |
| Corn cob | 2.00 | 0.50 | 54.00 | 31.00 |
| Corn and cob meal | 8.00 | 3.00 | 63.00 | 7.50 |
| Corn, ear, with shuck | 7.75 | 2.75 | 62.00 | 10.00 |
| Corn, ear, without shuck | 8.00 | 3.00 | 63.00 | 7.50 |
| Corn feed meal | 8.00 | 3.25 | 68.00 | 4.00 |
| Corn germ meal | 10.00 | 3.50 | 66.00 | 5.00 |
| Cotton seed | 23.00 | 20.00 | 25.00 | 18.00 |
| Cottonseed cake | 44.00 | 8.00 | 24.00 | 8.00 |
| Cottonseed chops | 23.00 | 20.00 | 25.00 | 18.00 |
| Cotton seed, cold pressed | 26.00 | 6.50 | 28.00 | 26.00 |
| Cotton seed, ground cold pressed | 26.00 | 6.50 | 28.00 | 26.00 |
| Cottonseed hulls | 3.00 | 0.25 | 28.00 | 54.00 |
| Cottonseed meal | 44.00 | 8.00 | 24.00 | 8.00 |
| Flax seed | 22.00 | 33.00 | 23.00 | 7.50 |
| Gluten meal | 29.00 | 11.00 | 46.00 | 3.50 |
| Grits, seconds | 11.00 | 7.00 | 64.00 | 5.00 |
| Hominy feed | 9.00 | 6.00 | 60.00 | 6.50 |
| Kafir chops | 10.25 | 2.75 | 68.75 | 2.75 |
| Kafir head chops | 9.25 | 2.50 | 65.50 | 7.25 |
| Kafir meal | 11.00 | 1.50 | 68.00 | 2.50 |
| Linseed meal, new process | 33.00 | 3.00 | 38.00 | 10.00 |
| Linseed meal, old process | 32.00 | 7.50 | 35.00 | 9.00 |
| Meat scrap | 71.00 | 13.00 | 0.25 | ..... |
| Mill screenings | 9.00 | 3.00 | ..... | 20.00 |
| Millet seed | 11.00 | 4.00 | 57.00 | 10.00 |
| Milo chops | 10.00 | 2.50 | 70.50 | 3.00 |
| Milo head chops | 9.50 | 2.25 | 65.00 | 7.50 |
| Molasses, blackstrap | 2.40 | ..... | 65.00 | ..... |
| Oats | 11.00 | 5.00 | 59.00 | 10.00 |
| Oat feed | 15.00 | 7.00 | 59.00 | 7.00 |
| Oats, ground | 11.00 | 3.50 | 57.00 | 12.00 |
| Oat hulls | 3.00 | 1.00 | 51.00 | 30.00 |
| Oat shorts | 14.00 | 3.00 | ..... | 4.00 |
| Peanut cake, cold pressed | 30.00 | 10.00 | 23.00 | 23.00 |
| Rice bran | 11.50 | 11.50 | 44.00 | 11.50 |
| Rice, ground rough | 7.00 | 1.75 | 63.00 | 10.00 |
| Rice hulls | 3.00 | 0.50 | 37.00 | 36.00 |
| Rice mill screenings | 9.00 | 3.00 | ..... | 20.00 |
| Rice polish | 11.50 | 9.00 | 60.00 | 3.25 |
| Rye chops | 10.00 | 1.50 | 72.00 | 2.00 |
| Sorghum seed | 9.00 | 3.50 | 69.00 | 3.00 |
| Sunflower seed | 16.00 | 21.00 | 21.00 | 30.00 |
| Wheat bran | 16.00 | 3.50 | 54.00 | 9.00 |
| Wheat chops | 14.00 | 2.00 | 65.00 | 4.00 |
| Wheat flour, high grade | 14.00 | 2.00 | 70.00 | 0.50 |
| Wheat flour, low grade | 13.00 | 2.00 | 68.00 | 2.50 |
| Wheat mixed feed | 16.50 | 4.00 | 55.00 | 8.50 |
| Wheat shorts | 17.00 | 3.50 | 60.00 | 4.50 |
| Wheat screenings | 14.00 | 2.00 | 54.00 | 5.50 |

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR No. 7, NEW SERIES APRIL, 1915

DIVISION OF ENTOMOLOGY

# INSECT ENEMIES OF SUDAN GRASS

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES COMPANY, PRINTERS
1915

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BY

WILMON NEWELL, M. S.

Entomologist in Charge; State Entomologist

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# INSECT ENEMIES OF SUDAN GRASS.

BY

WILMON NEWELL, M. S., ENTOMOLOGIST IN CHARGE; STATE ENTOMOLOGIST.

As a result of the wide publicity given to Sudan grass by the Texas Experiment Station this plant has become one of the important crops on Texas farms. Like all other crops, Sudan grass is subject to attack by injurious insects and many inquiries are received at the Station for information concerning them. The present paper is, with minor modifications, one read by the writer before the meeting of the American Association of Economic Entomologists, held at Philadelphia, Pa., in December, 1914.

The insects thus far encountered as serious enemies of Sudan grass are not new pests, either to farmers or entomologists, but are, on the contrary, insects which have been with us for many years and which have found Sudan grass to their liking. These insects may be divided into two classes, those which destroy the seed, either in process of its development or after its harvest, and those which attack only the growing crop, reducing the amount of forage which it may produce. The former class is of interest to those farmers who grow Sudan grass primarily for seed and the latter class to both those who grow it for seed and for hay or ensilage. The former class will be considered first.

## THE SORGHUM MIDGE.*

The sorghum midge is perhaps of most importance, of all the insects affecting Sudan grass, on account of its destruction of the seed before maturity. It does not in any way interfere with the growth of the plants or the amount of hay or forage which they produce. The midge has been familiar to growers of sorghum, milo maize and related crops for many years, there being many localities in the South where it entirely prevents the maturing of seed of these crops. It is essentially an insect of regions of rather heavy annual rainfall, or high humidity.

### DISTRIBUTION AND DAMAGE.

In sections of the State having a heavy annual rainfall it is doubtful if seed crops of Sudan grass will ever be produced with any certainty. Especially is this true in humid sections where Johnson grass is prevalent, as this grass affords a constant breeding place for the pest. The only portion of the State entirely exempt from the midge is the western part, where the rainfall is usually less than 25 inches per year.

During the past two seasons Sudan grass has been grown both at the main Station at College Station and at each of the eleven sub-stations, and this has given us a good general knowledge of the distribution and abundance of the insect. The following table shows the location of

---

*_Contarinia (Diplosis) sorghicola_, Coq.

these stations, the annual rainfall and the estimated damage to the Sudan grass seed crop during the past two years:

| Station. | Average Annual Rainfall. | | Estimated Damage to Seed Crop, Sudan Grass. —Per Cent. | |
|---|---|---|---|---|
| | Length of Record-years | Inches | 1913. | 1914. |
| Angleton | 18 | 49.54* | 100 | 95 |
| Nacogdoches | 7 | 45.44† | 60 | 100** |
| Troup | 9 | 43.79 | 100 | 100 |
| Beaumont | 20 | 42.65†† | 20 | 100 |
| College Station | 24 | 37.87†† | 40 | 95** |
| Chillicothe | 8 | 33.64 | | |
| Temple | 28 | 33.36†† | | 50 |
| Denton | 1 | 33.14 | 15 | 50 |
| Beeville | 18 | 30.05†† | | 50 |
| Lubbock | 3 | 21.74 | | |
| Spur | 3 | 18.40 | | |
| Pecos | 4 | 7.93 | | |

This table shows that localities having an average annual rainfall of 35 inches or more have experienced almost total destruction of the seed crop for the past two years, whereas localities with an average rainfall of about 25 inches or less have been exempt from damage. Between these two extremes, i. e., in localities where the average rainfall is between 25 and 35 inches, the amount of damage has been highly variable.

Sufficient data is not yet at hand to permit of any positive correlation between local climatic conditions and the extent of midge injury. However, it appears in general that, the greater the precipitation during the spring and early summer months, the greater is the damage by the midge. This is indicated by the data given below:

| Station. | 1913. | | 1914. | |
|---|---|---|---|---|
| | Rainfall, May, June and July, Inches. | Damage by midge. Per Cent. | Rainfall, May, June and July, Inches. | Damage by midge. Per Cent. |
| Beaumont | 9.66 | 20 | 32.64 | 100 |
| College Station | 4.03 | 40 | 9.45 | 95 |
| Temple | 5.02 | | 16.02 | 50 |
| Denton | 8.44 | 15 | 4.77 | 50 |
| Beeville | 5.45 | | 12.62 | 50 |

## DESCRIPTION.

The adult midge (see Figure 1) is a very small, delicate fly, two-winged, with orange-colored thorax and abdomen, a yellow head and brown legs and antennæ. The female is only about 2 millimeters (about one-twelfth of an inch) in length, with a wing expanse of not over one-eighth of an inch. The male midge is somewhat smaller. So small and delicate are these insects that the average farmer does not notice them at all. The adults are also short-lived and are to be found only when the females are laying their eggs in the blossoming heads or

*U. S. Weather Bureau record at Alvin, 20 miles from Angleton.
**A small seed crop produced very late in the season.
†U. S. Weather Bureau record at Lufkin, 15 miles from Nacogdoches.
††U. S. Weather Bureau record.

when they are reaching maturity and emerging from the seed pods three to four weeks after blossoming time. The midge in appearance is not unlike the Hessian fly of wheat and belongs to the same family.

Most of our knowledge regarding the life history and development of the midge is due to the investigations of Mr. Wm. Harper Dean, formerly assistant entomologist of this Station, whose results were published in Bulletin No. 85 of the Bureau of Entomology, United States Department of Agriculture.

The eggs, laid by the female midges within the glumes at blossoming time, are very tiny, being only 0.15 mm. (about 1-166th of an inch) in length, and are sharply tapered at one end. The favorite place for de-

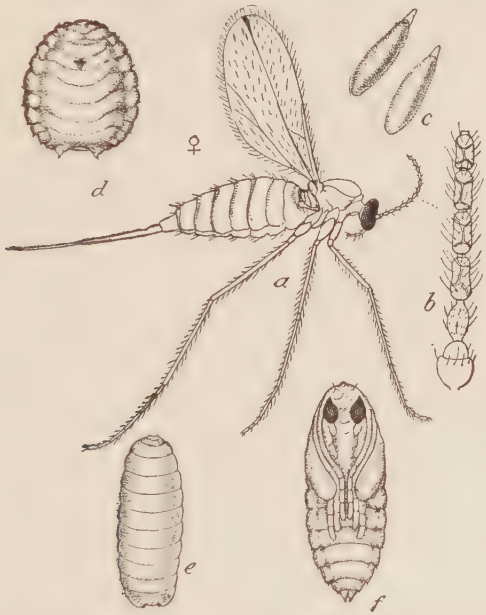


Fig. 1.—The sorghum midge: *a*, adult female; *b*, antennal joint of same; *c*, eggs; *d*, fully developed larva as found in cocoon; *e*, larva in early stage; *f*, pupa. All much enlarged. (After Dean, Bul. 85, Bureau of Entomology.)

positing the egg is within the glumes, or sheath-like envelopes covering the ovary, and as near to the latter as possible. The sorghum or Sudan grass head, opening gradually, offers a succession of blossoms in the right stage for oviposition; hence eggs are laid on each head for several days in succession. As all plants do not blossom at the same time, a succession of individual blossoms is also available for egg deposition. This still further lengthens the period in which egg-laying may take place and results in the midge being found in all stages of delevopment from almost the very beginning of the season.

The larva which hatches from the egg above-described is a very small pink or yellow "maggot," devoid of legs or other prominent structures. If hatched from an egg placed against the ovary of the blossom, it is already in position to commence feeding. Nourishment is taken by absorption of the juices from the ovary through the body-wall of the

larva. As the larva grows older it becomes red in color and when full-grown rarely exceeds one-half millimeter (1-50th of an inch) in length. The larval development requires about 11 days. As the ovary becomes discolored at the point of attack it is not difficult to find the larvae in infested seed heads.

When the larva completes its growth it transforms to a pupa without changing its position next to the young seed, the latter now "blasted." The pupa is red and darkens perceptibly as the time approaches for transformation to the adult midge. The pupal stage lasts from 3 to 5 days, at the end of which time the pupa works its way to the apex of the seed. Here, half protruding into the open air, the pupal skin splits open and from it emerges the adult midge.

Mating of the adult males and females occurs practically as soon as they are dry enough to fly and deposition of eggs by the females commences almost immediately afterwards.

Owing to the constant succession of opening heads of Johnson grass, sorghum, milo maize, and related plants throughout the season, the midge can be found in all stages of development from spring until late fall. Consequently there are no marked broods or generations. However, it is interesting to notice what possibilities for enormous increase this insect possesses. Mr. Dean found that the complete life cycle varied from 14 to 23 days, that throughout the season the proportion of females to males was as three to one and dissections of egg-laying females frequently showed upwards of 100 eggs in each. On the assumption that Johnson grass is heading by May 15th and is available for egg deposition, that the average number of eggs laid by each female is but 40, and that seed heads of Johnson grass, Sudan grass, etc., are available for egg-laying until October 1st, there is ample time for the development of six complete generations. Computations from this data, making allowance for the production of three females to each male, show that the progeny resulting from one pair of midges, between May 15th and October 1st, would be 972,000,000. Of course such tremendous increase does not occur, simply because all seed heads are blasted long before these numbers are reached. The rate of increase does, however, prevail as long as the supply of uninfested seed heads holds out and it shows very plainly why it is utterly useless to attempt to grow sorghum or Sudan grass seed in localities where climatic conditions are favorable for the midge's development. It shows, at the same time, why even the best methods for controlling the pest are unavailing when seasonal conditions are favorable for the insect.

## HIBERNATION.

All through the season a certain proportion of the larvae develop cocoons about themselves. When cold weather approaches in autumn all larva that are not covered with these cocoons perish. The "cocooned" ones (see Figure 2), however, are well protected by this covering as well as by the seed heads in which they occur and in this stage they successfully withstand freezing weather, to develop through the pupal stage to adults the following spring. Hiberation, therefore, takes place in the old seed heads of Johnson grass, sorghum and similar plants in the field and, to a lesser extent, in the threshed seed carried over by the planter.

Theoretically, the destruction of all such seed heads by burning, and the winter fumigation of all seed, should bring the pest under control. To accomplish this end with perfection is manifestly impossible, owing to the difficulty of finding and destroying all seed heads of the sorghum family, both wild and cultivated.

Fig. 2.—The "cocooned larvae," the hibernating form of the sorghum midge. Much enlarged. (After Dean, Bul. 85, Bur. of Entom.)

## PREVENTIVE MEASURES.

As was shown in the table on page 6, sections which have an average annual rainfall of 35 inches or over experience, as a rule, complete destruction of the seed crop, both of sorghums and Sudan grass. In such sections the production of Sudan grass seed should not be attempted, for all the preventive measures which the farmer can take cannot offset the great advantage which the midge has for rapid reproduction.

Figure 3, taken from Bulletin No. 172, shows the State divided into three sections with reference to annual rainfall. The amount of rainfall is quite closely correlated with the amount of damage by the midge, as shown by the table just referred to. Farmers located in the area represented by the unshaded portion of the map should not attempt to grow Sudan grass seed, but should confine their use of this crop to the production of hay and ensilage.

In the lightly shaded section, of intermediate rainfall, the farmer has a fair chance to produce crops of seed by the rigid practice of the preventive measures given below. Even in this section seasons of exceptional rainfall may offset all measures taken against the midge and at best the production of seed in this area is more or less uncertain.

In the heavily shaded section, that of little rainfall, the combination of climatic conditions unfavorable to the midge and the measures outlined below will usually insure a good crop of seed. Though the midge seems to be very scarce or lacking in the drier parts of this area, it must be remembered that seasons of rather heavy rainfall, favorable to the midge, will occur now and then and that the increased cultivation of Sudan grass will in itself afford a condition likely to result in the increase and prevalance of this insect. The preventive and control measures, even in this section, should therefore not be neglected.

## CONTROL.

Control measures consist of clean harvesting, winter destruction of seed heads, the destruction of Johnson grass and the fumigation of seed.

As the cocooned hibernating larvae remain in all seed heads which are not harvested and threshed, the importance of thoroughly gathering all heads at harvest time is self-evident. After the harvest the fields should be closely raked and the heads obtained should be threshed or burned. Thereafter the fields should be burned over, if possible, and then plowed deeply early in the winter. This applies to all fields which

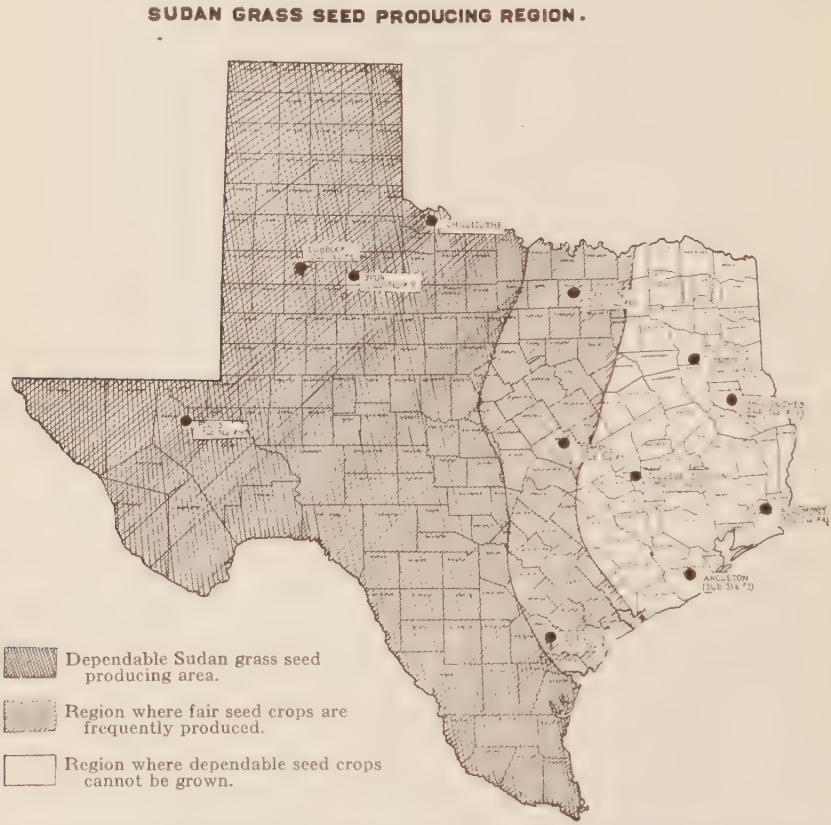
SUDAN GRASS SEED PRODUCING REGION.
Dependable Sudan grass seed producing area.
Region where fair seed crops are frequently produced.
Region where dependable seed crops cannot be grown.

Fig. 3.—Map showing regions in Texas where dependable seed crops can and cannot be grown on account of prevalence of the sorghum midge.

have been in sorghum, Sudan grass, milo maize and all other crops of this family.

The destruction of Johnson grass is perhaps the most vital step in control of the midge. All Johnson grass areas should be burned over during the fall or winter in such manner as to destroy all the seeds and such areas should be plowed deeply in the spring to prevent an early crop of Johnson grass heads in which the midges will breed before the earliest Sudan grass heads out. The complete destruction of Johnson grass, or at least the prevention of its heading, is even more to be desired. Were Johnson grass absent, it is probable that clean cultural

methods and fumigation of seed would control the midge, even in localities now heavily infested.

All seed carried through the winter should be fumigated with bisulphide of carbon to destroy any hibernating larvae in it. The method of fumigation is comparatively simple and easy and not only destroys the sorghum midge larvae, but also all other insects which infest the seed. A full description of the fumigating methods is given below under the discussion of the Angoumois grain-moth.

## THE ANGOUMOIS GRAIN-MOTH.*

This insect does not prevent the Sudan grass from "making" seed, but the adult moths deposit their eggs in the seed heads before the latter are harvested. The harvested seed then becomes infested with the larvae and the insect continues to breed in the stored seed. The moths will also lay their eggs upon any Sudan seed or other grain to which they obtain access.

During September and October, 1914, the moths were noted in great abundance among the heads of uncut Sudan grass at Robstown, Texas, as well as in the shocks of harvested Sudan awaiting threshing. During the warmer days of November, also, they were abundant around the bins in which the seed had been stored. During February and March, 1915, adult moths developed in Sudan grass seed harvested at College Station late the preceding autumn.

### DESCRIPTION AND LIFE HISTORY.

The adult moth (Figure 4, *e* and *f*) closely resembles an ordinary

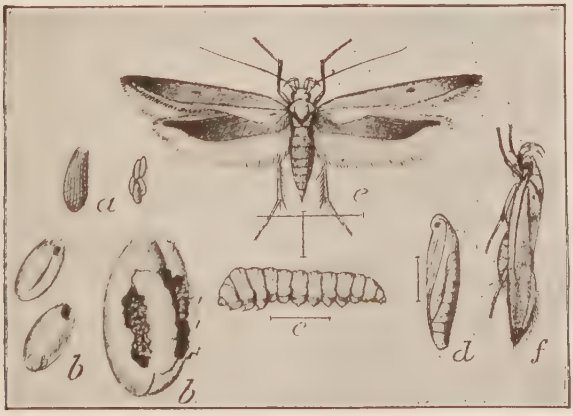


Fig. 4.—The Angoumois grain-moth: *a*, eggs; *b*, larva at work in kernel of corn; *c*, larva, side view; *d*, pupa; *e*, moth; *f*, same, side view. (After Chittenden, Farmers' Bulletin No. 45.)

clothes-moth, being yellowish or buff in color and with a wing expanse of not over one-half inch. The wings, when expanded, are slightly mottled with black, as shown in the illustration.

**Sitotroga cerealella*, Olin.

The eggs are laid upon the sides of the seeds and each female may deposit from 60 to 90, these being generally distributed over several seeds or kernels of grain. In warm weather these eggs hatch in from 5 to 7 days.

The larvae burrow into the seeds and hollow out the interior, often leaving a mere shell. These larvae become full-grown in about three weeks, spin cocoons within the hollowed-out seeds, transform to pupae and in a few days more emerge as adult moths. Owing to the rapidity with which each generation develops, several generations may occur during the year and the damage to stored seed may be very heavy, amounting sometimes to the destruction of from 50 to 80 per cent. of it. A peculiarity of the infestation by this insect is the resultant "heating" of heavily infested seed.

The winter is passed both out-of-doors, as larvae in seed left in the fields, and in stored grain or seed. In the latter, especially if the building is warm or the winter weather rather moderate, breeding continues throughout the winter.

## CONTROL.

Thorough cleaning up and deep plowing of the fields, as recommended for the sorghum midge, will dispose of the insects hibernating in the fields. The greatest supply of the moths comes, however, from seed kept over winter and it is to this seed that by far the greatest damage is done. As soon as seed is found infested—and the occurrence of moths in and around the seed is a sufficient indication that it is infested or about to become so—it should be fumigated and the fumigation repeated as many times as it may become reinfested.

Fortunately, Sudan grass seed shows a high resistance to injury by carbon bisulphide. Its fumigation is therefore fraught with little or no danger of injury to the germinating power of the seed. In experiments which we have made to determine whether its germinating power might be affected by heavy fumigation it was found that as much as 15 pounds to the 1000 cubic feet of bisulphide, confined for 12 hours, did not affect germination. In some instances the fumigation even appeared to stimulate germination of the seed. The germination tests were made in seed testers, both immediately after the fumigation and again nine weeks later. The results of a few of these fumigations are given in the table below:

GERMINATION OF SUDAN GRASS SEED FUMIGATED WITH CARBON BISULPHIDE AT DIFFERENT STRENGTHS.

| Date of Fumigation. | Amount of Carbon Bisulphide per 1,000 cubic feet. | Per Cent of Germination, Sept. 5-10. | Per Cent of Germination, Nov. 16-20. |
|---|---|---|---|
| Sept. 1-5 | 1 lb. | 91 | 90 |
| Sept. 1-5 | 3 lbs. | 88 | 90 |
| Sept. 1-5 | 5 lbs. | 97 | 91 |
| Sept. 1-5 | 8 lbs. | 83 | 94 |
| Sept. 1-5 | 10 lbs. | 91 | 91 |
| Sept. 1-5 | 15 lbs. | 86 | 78 |
| (Not fumigated) | Check No. 1 | 86 | 83 |
| (Not fumigated) | Check No. 2 | 86 | 83 |

METHODS OF FUMIGATING.

Carbon bisulphide is the only suitable substance to use in fumigating seeds of this kind.

Where only a few bushels, or less, are to be treated, the writer prefers to use a simple and inexpensive outfit consisting of a tight whisky or

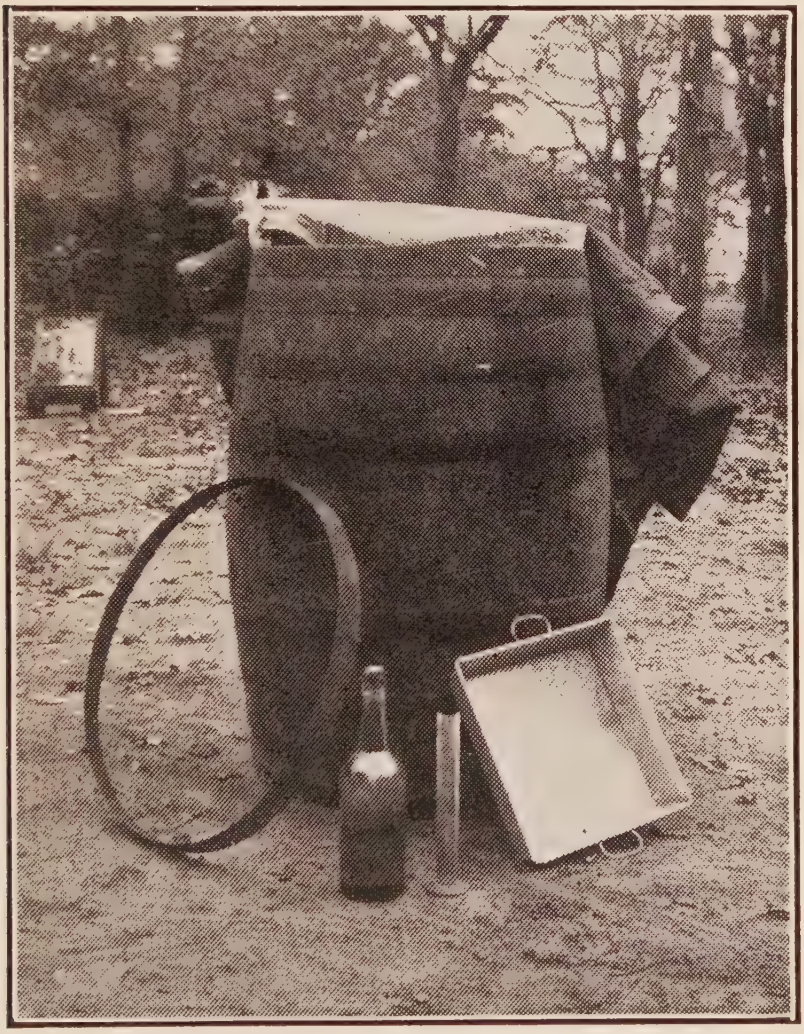

Fig. 5.—An inexpensive outfit for fumigating Sudan grass and other seeds with carbon bisulphide. (Original.)

alcohol barrel, a 12x12-inch iron baking pan, a few large sheets of newspaper, a piece of heavy canvas or a tarpaulin and an extra barrel hoop somewhat larger than the open end of the barrel. Such an outfit is shown in Figure 5.

The seed to be fumigated are placed in the barrel and on top of them

is placed the shallow iron pan. It matters not whether the barrel contains a few quarts of seed, or whether it be filled to within 6 inches of the top. Sufficient space should always be left so that the top edges of the pan, when placed on top of the seed, are at least 3 inches below the top edge of the barrel. The canvas or tarpaulin is next smoothly folded into a square somewhat larger than the top of the barrel and the three or four thicknesses of the newspaper laid out flat, ready for covering the barrel. The amount of bisulphide, accurately measured, is now uncorked, poured quickly into the iron pan, the paper laid smoothly over the open end of the barrel, on top of it the folded canvas and the latter then forced down snugly and smoothly by putting on the extra iron hoop. The barrel should be left unopened for twenty-four hours, when the seed may be immediately removed and sacked in tight sacks to prevent reinfestation. The ordinary whisky barrel, of 52 gallons capacity, contains approximately seven cubic feet of space and the proper charge for this is one fluid ounce (30 cubic centimeters) of carbon bisulphide.* One should not guess at the amount. A glass measuring vessel, graduated to either cubic centimeters or fluid ounces, should be purchased from a druggist or dealer in photographic supplies and each charge should be carefully measured. The importance of this cannot be overestimated, for too small a charge of the liquid will fail to kill the insects, while too heavy a charge might injure the germinating power of the seed.

Immediately after fumigation, the seed should be sacked up, preferably in sacks of heavy cloth, such as canvas, free from holes, so that moths cannot get to the seed to start another infestation. It is advisable, nevertheless, for the owner to open and examine the seed every few weeks and if infestation is found the fumigation should be repeated.

There is no danger in handling carbon bisulphide except that all fire, such as lamps, lanterns, lighted pipes and cigars, etc., must be kept a safe distance from where it is kept or used. The vapor from it is highly explosive when coming in contact with fire. It will not explode from a sudden jar or rough handling. In general, one should use the same precaution as with gasoline, but should remember that the bisulphide changes to a gas more rapidly and the gas sinks to the ground instead of rising. It is well to have the fumigating barrel out-of-doors, at least 50 feet from the nearest building, keeping it there at all times and doing all fumigating in it there. Bad weather does not interfere with this plan, for the canvas cover will shed all rainwater—if it does not, it isn't a tight enough cover to fumigate with.

Seed stored in bins, either loose or in thin sacks, can be fumigated by practically the same method, except that the building or bin containing them must be made practically air-tight beforehand. Where the seed are in a tight bin the latter may be covered with tarpaulins or blankets to confine the gas, the covering being supported above the iron pans sufficiently to allow the free evaporation of the liquid. This is easily accomplished by means of a stick stuck down into the seed by each pan, the top of the stick remaining about six inches out of the seed.

*Equivalent to approximately nine pounds of bisulphide per 1000 cubic feet of space.

The cubic contents of the bin should be carefully ascertained. Multiply its width, in feet, by its length and this product by its height and the resulting figure will be the number of cubic feet in it. As in the case of the barrel fumigation, nine pounds of the bisulphide should be used to each 1000 cubic feet of space. This rule applies regardless of whether the bin is full or only part full. If there are cracks in the bin or building that allow any escape of gas, a little more of the liquid should be used to make up for that lost through leakage.

Fumigation of buildings, or in buildings, is fraught with much more danger than fumigating in barrels or tanks outside, mainly on account of the difficulty in keeping all smokers out of the building and away from it and also on account of the larger quantity of bisulphide causing the gas to spread to a greater distance. Where it is possible to fumigate out-of-doors, using barrels, we strongly urge that it be done in this way, even if several barrels have to be used or several days taken to complete the fumigation of all seed.

Carbon bisulphide should be obtainable from any druggist at a price varying from 18 to 20 cents per pound. The manufacturer's price on bisulphide in quantity, at the factory, is usually 10 cents per pound, with a charge for shipping tank of about 2 cents per pound. Where much bisulphide is to be used in a neighborhood, money will be saved by the farmers clubbing together and ordering the bisulphide direct from the maker. The writer of this will be glad, on request, to place anyone in touch with the manufacturers.

## THE CONCHUELA.*

Strangely enough, the area in which the sorghum midge is scarce or absent, on account of insufficient moisture, is the one in which the conchuela reaches its greatest abundance. This insect is a "stink-bug" (see Figure 6) about 15 mm. (three-fifths of an inch) in length, of usually a dark brown color, though sometimes of green, purple or gray tint. It may be recognized by the brilliant yellow or crimson lateral margins of the thorax, similar brightly colored front margins of the wings and a spot of the same color at the tip of the scutellum, the latter being about in the center of the insect's "back."

This insect both in the young and adult stages feeds by inserting its beak into the tissues of the plant, either stem or seed head, and sucking out the sap. The result is a rapid wilting or "burning" of the infested plants and their heads. This plant-bug is a very general feeder, attacking cotton, small grains, alfalfa, foliage of trees, garden vegetables, etc., but is particularly severe in its attacks on all members of the sorghum family, Sudan grass included. Its abundance in certain semi-arid sections is, in some seasons, almost beyond belief. In Loving county, for example, there were neighborhoods the past season where the insect even prevented, to a large extent, the seed production of Johnson grass.

---

*_Pentatoma ligata_ Say,

Thus far large areas of Sudan grass have not been grown in the localities where the conchuela is at present abundant, but, owing to its fondness for all other members of the sorghum family, there seems little doubt that it will prove to be a serious obstacle to the extended cultivation of Sudan grass in parts of the semi-arid region.

One of our correspondents, Mr. A. S. Whitten, of Porterville, Texas, has observed these insects hibernating in piles of wood, weeds and trash generally. The method of hibernation would suggest, as remedial measures, the early deep plowing of infested fields and a thorough winter cleaning up and burning of all rubbish affording hibernating quarters for the insect. Morrill* also recommends the destruction of all mesquite trees in the vicinity of infested fields, as the mesquite is one of the favorite native host plants of the insect.

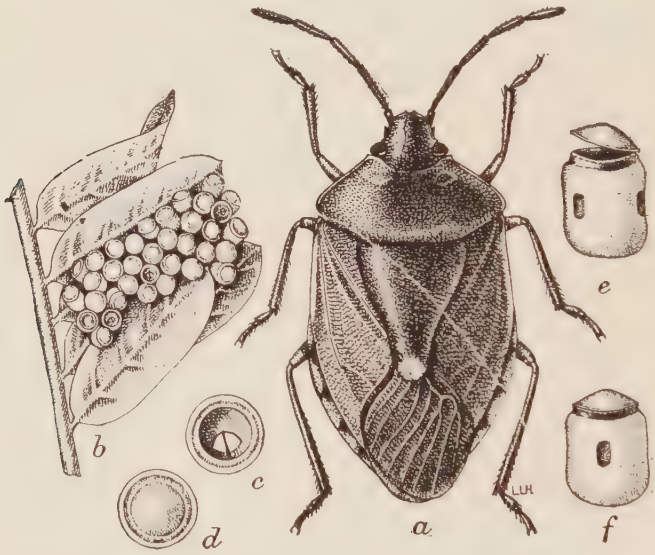


Fig. 6.—The conchuela: *a*, adult bug; *b*, mass of eggs on leaves; *c*, egg just before emergence of nymph; *d*, egg at an earlier stage of development; *e*, egg from side showing exit hole at the top; *f*, egg closed. All enlarged. (After Morrill, Bul. 86, Bureau of Entomology.)

## GRASSHOPPERS.

Grasshoppers of all kinds and ages find the rapidly growing shoots of Sudan grass particularly attractive and sometimes injure the crops severely unless checked in time. Preventive and control measures against grasshoppers consist of winter destruction of their egg masses by plowing and cultivation, poisoning the vegetation in spots where the eggs are hatching in large numbers, and the use of attractive poisoned baits in the fields themselves.

Grasshopper outbreaks are more easily prevented than cured. All ditch banks, turn-rows and fence rows, as well as all fields, should be

*Bulletin 86, Bureau of Entomology.

plowed during the fall and early winter. This destroys the grasshopper eggs which are laid in the ground by the female grasshoppers during late summer.

### SPRAYING THE WEED PATCHES.

The grasshopper eggs hatch quite early in spring, the time depending largely upon the temperature. In the latitude of College Station, with a warm spring, young hoppers may be found as early as April 1st and hatch in increasingly large numbers until well into May.

While still very small the young hoppers feed on the weeds and grasses near where they hatch out. Many of them can be killed by spraying these places with the following mixture:

| | |
|---|---|
| Sodium arsenite | 1 lb. |
| Molasses | 1 gal. |
| Water | 50 gals. |

One-half pound of Paris green may be substituted for the pound of sodium arsenite if desired. This spray must not be used on the Sudan grass, cotton, or other crop; only on the grass and weed patches, and care must be taken to keep all stock from grazing on these patches until after several hard rains have fallen on them.

### USING POISON IN THE FIELDS.

When the measures recommended above, i. e., winter plowing of breeding grounds and use of poison where the grasshoppers are hatching, have been neglected or have proven insufficient, it becomes necessary to use a poisoned bait for destruction of the insects among the growing crops. While many poisonous mixtures have been tried and recommended, by far the most satisfactory is one perfected during 1913 by Prof. Geo. A. Dean, State Entomologist of Kansas, and now generally known as the "Kansas grasshopper poison." We had many occasions to recommend the use of this mixture during the spring of 1914, and in all cases satisfactory results were reported. This mixture is made as follows:

| | |
|---|---|
| Bran | 20 lbs. |
| Paris green, or white arsenic | 1 lb. |
| Syrup | 2 qts. |
| Lemons | 3 |
| Water | 3½ gals. |

In preparing this bran mash, mix the bran and Paris green, or white arsenic, thoroughly in a wash tub while dry, or by shoveling over several times on a smooth floor. Squeeze the juice of the lemons in the water, and chop the remaining pulp and the peel to fine bits and add them to the water. Dissolve the syrup in the water and wet the bran and poison with the mixture, stirring at the same time so as to dampen the mash thoroughly.

The addition of the lemons makes the mixture very attractive to the hoppers and they usually prefer it to all other kinds of food.

The damp mash or bait should be sown broadcast in the infested areas early in the morning, or about the time the grasshoppers are beginning

to move about from their night's rest. It should be scattered in such a manner as to cover from four to five acres with the amount of bait made by using the quantities of ingredients given in the above formula. Since very little of the bran mash is eaten after it becomes dry, scattering it broadcast in the morning, and very thinly, places it where the largest number will find it in the shortest time. Sowing it in this manner also makes it impossible for birds, barnyard fowls, or live stock to secure a sufficient amount of the poison to kill them. On alfalfa fields, in order to secure the best results, the bait should be applied after a crop has been removed and before the new crop has started. Inasmuch as the poisoned bait does not act quickly, it will be from two to four days before the grasshoppers are found dead, and these will be more numerous in the shaded places. It does not require much of the poison to kill them. Even a small portion from one of the poisoned flakes is sufficient to cause death. Where the grasshoppers are still confined to the edges of the fields, scatter the poison thickest along the edge and in the weeds and grass adjoining.

## OTHER INSECTS.

As Sudan grass is still a comparatively new crop, we do not know what other insects may find the plant to their liking. The writer will appreciate the co-operation of farmers and others in advising him as to the occurrence of other insect pests upon Sudan grass, should any be observed.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 8, NEW SERIES OCTOBER, 1915

DIVISION OF ENTOMOLOGY

# THE TEXAS FOUL BROOD LAW

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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BY

B. YOUNGBLOOD, M. S., Director

POSTOFFICE:

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1915

# THE TEXAS FOUL BROOD LAW.

BY

B. YOUNGBLOOD, M. S., DIRECTOR.

The present foul brood law of Texas was enacted by the Thirty-third Legislature, approved March 27, 1914, and became a law ninety days later. It embodies many advantages over the previous law.

The Entomologist in Charge, Division of Entomology, Texas Agricultural Experiment Station, is named in the law as the State Entomologist who is charged with the enforcement of the law.

The law was secured by virtue of the activities of the beekeepers of the State and the appropriation for use in its enforcement was secured largely through their efforts.

The beekeeping industry of this State has suffered heavy losses because of the existence of foul brood. Some headway was being made against it, however, until two years ago, when the Legislature failed to make provision for support of this work. During the year and more that followed before an appropriation was secured, foul brood spread back into many sections from which it had hitherto been eradicated. Headway is again being made under the best financial support for the work in the history of the State.

Upon the resignation of Mr. Wilmon Newell, Mr. F. B. Paddock was named as his successor and to him falls the enforcement of the law. Mr. Paddock is well fitted for the work for several reasons. He is a graduate in entomology from the Colorado State Agricultural College and has done three summers' advanced work at the Ohio State University under Professor Herbert Osborn, one of the most distinguished entomologists in the country. Most of this work at Ohio has been founded upon Texas insect problems. During his four years under Mr. Newell, Mr. Paddock secured much practical experience with bees and familiarity with the foul brood eradication work.

It is fortunate indeed that Mr. Paddock has always pursued the plan of mixing practical experience with theoretical training. After spending his first three years in college, he spent three years in practical work with the Great Western Sugar Company, in Colorado. He then returned to college for another year and secured his degree. This much concerning Mr. Paddock is given in order that the beekeepers of the State may know something of the man selected to serve them in connection with their foul brood and other problems.

The inspection work is conducted by local county foul brood inspectors appointed by the State Entomologist, subject to the approval of the Director and the Board of Directors of the Texas Agricultural Experiment Station. These inspectors are suggested to the State Entomologist by the county beekeepers' associations. No inspector is appointed

unless the local association is properly organized and co-operates with the State Entomologist in suggesting the local inspector.

As provided in Section 9 of the law the State Entomologist will shortly issue regulations relative to the shipment of honey bees into counties where the foul brood eradication work is now being actively conducted. Any questions relative to the existence or treatment of foul brood, the shipment of bees, honey and appliances, should be addressed to the State Entomologist, College Station, Texas.

The foul brood law is for the protection of Texas beekeepers and the bee industry. With the co-operation of the beekeepers much can be accomplished. Suggestions will be appreciated.

The full text of the foul brood law follows:

## THE FOUL BROOD LAW OF TEXAS.

General Laws of Texas, Thirty-third Legislature.

(H. B. No. 11.) CHAPTER 51.

An Act to amend Chapter CXXVI of the Acts of the Regular Session of the Twenty-eighth Legislature, entitled "An Act to provide for the protection of honey bees against foul brood and other contagious diseases, and providing that all beekeepers report to the State Entomologist when infectious diseases exist; providing for collecting the expense of eradicating the disease, and fixing the charges upon the owner or agent of the bees; providing for the extermination of all contagious diseases; and providing penalties for the violation of any of the provisions of this Act," and declaring an emergency.

*Be it enacted by the Legislature of the State of Texas:*

Section 1. That Chapter CXXVI of the Acts of the Regular Session of the Twenty-eighth Legislature be, and the same is, hereby amended so as to hereafter read as follows:

Section 2. That for the purpose of carrying out the provisions of this Act, the Entomologist of the Agricultural Experiment Station of the Agricultural and Mechanical College of Texas shall be the State Entomologist of this State, and as such it shall be his duty to enforce the provisions of this Act and to issue such rules, regulations, etc., as are hereinafter required. As State Entomologist he shall receive no fees or remunerations other than his regular salary as Entomologist of the Experiment Station and State Entomologist; provided, that he may be reimbursed for necessary expenses incurred in discharge of his duties as State Entomologist. He shall employ such assistants and inspectors as may be necessary, subject to the approval and confirmation of the Director and Governing Board of the Texas Agricultural Experiment Station. He shall make an annual report to the Director and Governing Board of the Experiment Station, such report giving a detailed account of all funds received and disbursed, and for what purpose, as well as a full report upon all prosecutions, etc., made under the provisions of this Act.

Section 3. The said State Entomologist shall have full and plenary power to deal with all contagious or infectious diseases of honey bees which, in his opinion, may be prevented, controlled or eradicated; and shall have full power and authority to make, promulgate and enforce such rules, ordinances, orders and regulations, and to do and perform such acts as, in his judgment, may be necessary to control, eradicate or prevent the introduction, spread or dissemination of any and all contagious diseases of honey bees as far as may be possible, and all the rules, ordinances, orders and regulations of said State Entomologist shall have the force and effect of the law in so far as they conform to the general laws of this State and the United States. The State Entomologist, in the exercise of the power and authority herein delegated, shall have authority to prohibit the shipment or bringing into this State of any honey bees, honey, honey-comb, or articles or things capable of transmitting contagious or infectious diseases of bees, from any State, Territory or foreign country, except under such rules and regulations as may be adopted and promulgated by said State Entomologist.

Section 4. All honey bees shipped or moved into this State shall be accompanied by a certificate of inspection signed by the State Entomologist or State Foul Brood Inspector of the State or country from which shipped. Such certificates shall certify to the apparent freedom of the bees, and their combs and hives, from contagious and infectious diseases and must be based upon an actual inspection of the bees themselves within a period of sixty days preceding date of shipment. The shipper of such bees is hereby required to file with the State Entomologist at College Station, Texas, at least ten days in advance of such shipment, a certified copy of said certificate, together with the names and addresses of both consignor and consignee; provided, that when honey bees are to be shipped into this State from other States or countries wherein no official apiary inspector or State entomologist is available, the State Entomologist of Texas may issue permit for such shipment upon presentation of suitable evidence showing such bees to be free from diseases. Shipments of bees arriving at points within this State, not accompanied by the certificate herein described, shall be subject to confiscation and destruction by the State Entomologist or his assistants. This requirement shall not apply to shipments of live bees in wire cages, when without combs or honey.

Section 5. It shall be unlawful for railroad companies, express companies or other common carriers to accept for shipment, between points within this State, any honey bees, used honey combs, used bee hives or fixtures, except under such regulations and provisions as the State Entomologist shall prescribe.

Section 6. The State Entomologist, through himself, assistants or inspectors, shall have authority to seize and confiscate any shipments of diseased bees found in transit in this State, or found in any depot, express office, storeroom, car, warehouse or premises awaiting transportation or delivery, and the State Entomologist, through himself or assistants, shall have authority to enter, during ordinary business hours, any depot, express office, storeroom, car, warehouse, or premises for

the purpose of inspecting any shipment of honey bees therein which he may have reason to believe are or may be infected with a contagious or infectious disease or which he may have reason to believe are being transported or have been or are about to be transported in violation of any of the provisions of this Act.

Section 7. In the discharge of the duties herein delegated the State Entomologist, and his assistants and inspectors, shall have authority to enter, during ordinary business hours, any premises, public or private, wherein may be located any honey bees, or wherein he or they may have reason to believe any honey bees are kept or located, for the purpose of examining said bees and determining whether or not they are infected with any contagious or infectious disease.

Section 8. The State Entomologist shall have authority to declare a protective quarantine in any district, county, precinct or other defined area wherein foul brood or other contagious disease of bees is not known to exist, or wherein any disease of bees is being eradicated in accordance with the provisions of this Act, said quarantine to prohibit the movement or shipment, into said district, county, precinct or other area, of any bees, honey, appliances or other things capable of transmitting the disease or infection, except under such rules and regulations as he shall prescribe.

Section 9. The State Entomologist shall have authority when, in his opinion, public welfare and necessity require it, to place a restrictive quarantine upon any district, county, precinct, or other defined area wherein are located any honey bees infected with contagious or infectious disease, said quarantine to prohibit the movement or shipment therefrom of any bees, honey, appliances or other things capable of transmitting the infection, except under such rules and regulations as he shall prescribe.

Section 10. Queen bees and their attendant bees shall not be sold or offered for sale in this State unless accompanied by a copy of a certificate from a State or government entomologist or apiary inspector to the effect that the apiary from which said queen bees are shipped has been inspected within the preceding twelve months and found apparently free from contagious and infectious diseases, or by a copy of a statement by the beekeeper made before a notary public or other officer having a seal that the bees are not diseased to the best belief of affiant, and that the honey used in making the candy contained in the queen cage has been diluted and boiled for at least thirty minutes in a closed vessel.

Section 11. Any person, firm or corporation violating any of the provisions of this Act, or violating any of the rules, quarantines, orders or regulations of the State Entomologist issued in accordance with the provisions of this Act, shall be deemed guilty of a misdemeanor, and shall, upon conviction thereof, be fined in any sum not less than twenty-five nor more than two hundred dollars. All prosecutions under this Act shall be commenced and carried on in any county of the State affected by the violation of said orders, quarantines, rules or regulations, and the said State Entomologist may enjoin any threatened or

attempted violation of his orders, quarantines, rules or regulations in any court of competent jurisdiction, or take any other civil proceedings necessary to carry out and enforce the provisions of this Act. It shall be the duty of the Attorney General and the various county and district attorneys to represent said State Entomologist, whenever called on to do so; and said State Entomologist, in the discharge and enforcement of the duties and powers herein delegated, shall have the authority to compel the production for examination by said State Entomologist, or anyone designated by him, of all books, papers and documents in the possession of any person; to take testimony, and compel the attendance and examination under oath of witnesses; and it is hereby made the duty of the various sheriffs and constables throughout the State to serve all papers, orders, summons and writs that may be delivered to them by said State Entomologist and to protect the State Entomologist or his assistants or inspectors in the discharge of their duties, as herein defined whenever called upon to do so. The State Entomologist is authorized when necessary to apply to any court of competent jurisdiction for the necessary writs and orders to enforce the provisions of this article, and in such cases he shall not be required to give bond.

Section 12. For the purpose of disseminating knowledge regarding honey bees and their diseases, the State Entomologist shall publish methods and directions for treating, eradicating or suppressing contagious or infectious diseases of honey bees, including the rules and regulations provided for in Sections 2, 3, 5, 8, and 9, and such other information as he shall deem of value or necessity to the beekeeping interests of the State.

Section 13. If any owner of, or person having control or possession of any honey bees in this State, knows that any bees so owned and controlled are affected with American foul brood, or any other contagious or infectious disease, or knows of any other bees so diseased, it shall be and is hereby made his duty to at once report such fact to the State Entomologist at College Station, Texas, setting out in his said report all the facts known with reference to said infection.

Section 14. The State Entomologist shall have full power in his discretion to order any owner or possessor of bees dwelling in hives without movable frames, or not permitting of ready examination, to transfer such bees to a movable frame hive within a specified time. In default of such transfer the State Entomologist may destroy, or order destroyed, such hives, together with the honey, frames, combs and bees contained therein, without recompense to the owner, lessee or agent thereof.

Section 15. If at any time the State Entomologist finds, or has reason to believe, that the owner or keeper of any bees, or the owner of any apiaries has refused or is refusing to comply with any or all of the rules and regulations hereinbefore provided for, then and in that event the State Entomologist is hereby authorized to inspect or cause to be inspected said bees, and, if necessary, burn diseased colonies, appliances and honey, and do any and all things necessary in the premises

to eradicate foul brood or any other contagious or infectious disease of bees.

Section 16. When any owner or possessor of bees shall fail to carry out the instructions of the State Entomologist as hereinbefore set forth, the State Entomologist or his assistants or inspectors shall carry out such destruction or treatment and shall present to the owner or possessor of said bees a bill for the actual cost of such destruction or treatment, including the cost of such hives, foundations, etc., as may be necessary for proper treatment of the disease. In the failure of the owner or possessor of such bees to pay said bill within thirty days after the delivery of same to himself, tenant or agent, or within thirty days after mailing same to his usual postoffice address the State Entomologist shall certify to the county attorney of the county wherein such bees were located, the amount and items of such bill; and the county attorney shall file suit for the recovery of said account. All moneys recovered by the county attorney for such destruction or treatment shall be paid into the hands of the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 17. If any owner or keeper of any diseased colonies of bees shall barter, give away, sell, ship or move any infected bees, honey or appliances, or shall expose any other bees to the danger of infection of the disease, or shall refuse or neglect to make report as provided in Section 13 of this Act, he shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not less than twenty-five nor more than two hundred dollars.

Section 18. It shall be unlawful for any person, firm or corporation to expose, on their own premises or elsewhere, any honey, hives, frames, combs, brood or appliances known to be infected by foul brood or other dangerous disease of bees, in such a manner that honey bees may have access to same; and it shall be unlawful to sell, offer for sale, barter, give away, ship or distribute any honey taken from a colony or colonies of bees infected with foul brood or other infectious or contagious disease. Violation of this section shall be deemed a misdemeanor and any person, firm or corporation convicted thereof shall be fined in any sum not less than twenty-five nor more than two hundred dollars.

Section 19. Anyone who shall seek to prevent any inspection of bees, honey or appliances under the direction of the State Entomologist, in accordance with this Act, or who shall attempt to prevent the discovery or treatment of diseased honey bees, or who shall attempt to intimidate the State Entomologist, or his assistants or inspectors, or otherwise interfere with them in the lawful discharge of their duties as herein defined shall be deemed guilty of a misdemeanor, and shall, upon conviction, be fined in any sum not less than twenty-five nor more than two hundred dollars. Prosecutions under the provisions of this section shall be instituted in any county of the State in which the offense is committed.

Section 20. All fines collected for prosecutions under the provisions of this Act shall be paid to the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 21. The State Entomologist, his assistants and inspectors, shall not be required to give bond or security in any legal proceedings which he or they may institute or defend in any court of justice in this State.

Section 22. All laws or parts of laws in conflict with or inconsistent with this Act be and the same are hereby repealed.

Section 23. The fact that American foul brood now exists and is destroying honey bees in at least twenty-two counties in Texas, and that there is now no adequate statute permitting the immediate suppression and control of this and other contagious diseases of honey bees, creates an emergency and an imperative public necessity requiring the suspension of the constitutional rule which requires bills to be read on three several days, and the same is so suspended, and this Act shall take effect and be in force from and after its passage, and it is so enacted.

NOTE.—H. B. No. 11 passed the House of Representatives March 8, 1913, but no vote given; passed the Senate by a two-thirds vote, yeas 28, nays 0.

Approved March 27, 1913.

Took effect 90 days after adjournment.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 9, NEW SERIES OCTOBER, 1915

# The Story of Three Pigs

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1915

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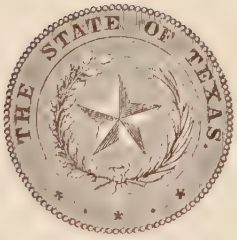
TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 9, NEW SERIES OCTOBER, 1915

# The Story of Three Pigs.

BY

L. B. BURK.




POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1915

# THE STORY OF THREE PIGS.

## A PRACTICAL DEMONSTRATION IN PIG FEEDING.

BY

L. B. BURK.*

The production of pork is often profitable or unprofitable, according to the methods used and the kind of feed given to the hogs. Numerous beginners, and many experienced feeders, are meeting with bitter disappointment because they expect to realize a profit by feeding hogs in a dry lot on corn or milo chops, alone.

Indian corn, milo, kafir, feterita, barley, rice bran and rice polish are feeds which have not proven satisfactory for fattening purposes when fed alone, nor have they given good results as growth-producing feeds, but they have proven highly satisfactory when supplemented with feeds high in protein, or muscle-and-bone-building material. Without this material the young pig cannot grow because his blood, bone, muscle, skin, hair, hoof and body tissues are all largely composed of protein. It is, therefore, necessary for hog feeders to realize that an abundance of cheap, home-grown fattening feeds are not sufficient. For best results a feed that will also furnish the growth-producing material must be supplied. Such feeds as tankage, cottonseed meal, skim milk, and various combinations of pasture grasses, especially the legumes, furnish supplements that are high in protein and have given excellent results.

It is the purpose of this brief circular to give an account of a test that has been conducted at the Texas Agricultural Experiment Station with three pigs, which demonstrates in a practical, forceful manner the importance of a supplement to milo chops when fed to growing pigs. It was conducted not to establish a truth, but to bring out more clearly a fact that has been proven time and again by nearly every experiment station in the United States; namely, that a well balanced ration, especially with growing animals, gives best results.

In order that the tabulated data might be more easily followed, the three pigs were named "Tom," "Dick" and "Harry." These three pigs were selected because they were neither unusually poor nor unusually good for their age. They were of the same color, conformation, and were brothers, from a litter of ten. At the beginning of the test they were much alike, except "Harry" was six pounds heavier than "Tom" and three and one-half pounds heavier than "Dick." They had the same care and were handled under the same conditions, except each received a different ration, and "Dick" and "Harry" remained in a dry

*Associate Professor of Animal Husbandry, Agricultural and Mechanical College of Texas.

lot all the time, while "Tom" grazed on mixed pasture, in addition to his grain ration.

The pigs were 62 days old when they were started on the test. They had been weaned a week previous to that time. On April 1, 1915, they were weighed and placed in their respective lots and given the following rations:

"Harry" was placed in a dry lot and given milo chops soaked in water between feeds.

"Dick" was placed in a dry lot and given milo chops and skim milk, the chops being soaked in the milk between feeds.

"Tom" was fed milo chops soaked in skim milk between feeds and allowed to graze on mixed pasture composed of burr clover, Bermuda, nut and crab grass.

The milk and milo were fed in the proportions of one pound of milo chops to two and one-half pounds of skim milk. Each of the pigs received all the feed he would clean up at all times.*

A careful and complete record was kept of all feed used. The initial and final weights were determined by taking the average of three weights taken at the same time of day for three consecutive days.

In determining the profit made by each pig, the feed was valued at average prices, as follows:

Milo chops .....$1.20 per 100 pounds.
Skim milk ..... .25 per 100 pounds.
Pasture ..... .05 per month.

The Fort Worth market quotations for April 1 and September 28, 1915, were used for the purpose of placing a value on the pigs.

Weekly weights were taken until August 1, when that practice was discontinued, due to hot weather and the fatness of "Tom" and "Dick."

On September 28 the final weights had been taken and the test was closed. The pigs were eight months old and had been on the test 180 days.

The following table gives the kind and amount of feed eaten each month and the results:

TABLE I.

SHOWING FEEDSTUFFS CONSUMED PER MONTH AND TOTALS.

| | "TOM." | | | "DICK." | | "HARRY" |
|---|---|---|---|---|---|---|
| Month. | Milo Chops. | Skim Milk. | Pasture. | Milo Chops. | Skim Milk. | Milo Chops. |
| April | 38 lbs. | 145 lbs. | all time | 55.5 lbs. | 202 lbs. | 54.5 lbs. |
| May | 92.5 lbs. | 268 lbs. | all time | 92.5 lbs. | 272 lbs. | 62 lbs. |
| June | 122 lbs. | 300 lbs. | all time | 120 lbs. | 300 lbs. | 58.5 lbs. |
| July | 124 lbs. | 310 lbs. | all time | 124 lbs. | 310 lbs. | 65.5 lbs. |
| August | 70 lbs. | 310 lbs. | all time | 124 lbs. | 305 lbs. | 87.5 lbs. |
| September | 96 lbs. | 315 lbs. | all time | 108 lbs. | 370 lbs. | 79.5 lbs. |

*"Tom" was cut down on grain during the month of August because it was decided to exhibit him at the Texas State Fair at Dallas, and to continue on full feed of grain would have rendered him unfit for this purpose.

The results of this test were very striking, but compare very favorably with the results obtained with large numbers of hogs at various experiment stations.

The following table shows the initial and final weights, and also the monthly weights:

TABLE II.

SHOWING WEIGHTS OF THE THREE PIGS AT THE END OF EACH MONTH.

| | "TOM." | "DICK." | "HARRY." |
|---|---|---|---|
| April 1, 1915 | 24.5 lbs. | 27 lbs. | 30.5 lbs. initial. |
| End of first month | 70 lbs. | 65 lbs. | 79 lbs. |
| End of second month | 116.5 lbs. | 107 lbs. | 65 lbs. |
| End of third month | 176 lbs. | 148 lbs. | 75 lbs. |
| End of fourth month | 230.5 lbs. | 187 lbs. | 88 lbs. |
| End of fifth month | 300 lbs. | 240 lbs. | 120 lbs. (estimated) |
| End of sixth month | 330 lbs. | 277 lbs. | 125 lbs. final. |

TABLE III.

SHOWING WEIGHTS AND GAINS.

| Pig. | Initial weight. | Final weight. | Total gain. | Average daily gain. |
|---|---|---|---|---|
| "Tom" | 24.5 lbs. | 330 lbs. | 305.5 lbs. | 1.697 lbs. |
| "Dick" | 27 lbs. | 277 lbs. | 250 lbs. | 1.38 lbs. |
| "Harry" | 30.5 lbs. | 125 lbs. | 94.5 lbs. | .52 lbs. |

It may be noticed from the table that although "Harry" was the largest at the beginning, during the first month he gained only eight and one-half pounds, while "Dick" made more than four times as much gain, and "Tom" more than five times as much in the same length of time. While "Harry" made a consistently slow gain, "Tom" and "Dick" made consistently rapid gains. This is the result that could be expected because "Harry" was not able to supply his body with enough growing material for proper development from the milo chops alone. On the other hand, the skim milk supplied the extra muscle and bone-building food in "Dick's" ration, and he grew and fattened rapidly. Although he made satisfactory gains they were not so great as the gains made by "Tom." The grass that "Tom" received kept his digestive organs in good condition and at the same time furnished an economical growing feed.

The feeding table shows, however, that there is another very apparent reason for the great difference in gains. While "Tom" consumed 1648 pounds of skim milk and 539.5 pounds of milo, and "Dick" 1659 pounds of skim milk and 624 pounds of milo chops, "Harry" ate only 407.5 pounds of milo chops. "Harry" did not consume nearly so much as did his two brothers, because he did not seem to like his feed. It was not palatable and he would leave it in his trough. A hog does not like a corn bread and water ration six months at a time, any more than a man would like it.

At first glance one might think this method economical, but it is this

kind of false economy that catches many. The fact is "Harry" consumed just enough feed to keep up his body, but nothing for profit. A hog, the same as any other animal, first consumes enough feed to maintain his body, and then uses all the extra feed consumed for making gains in the form of growth and fat. If he consumes only enough for maintenance he does not grow and consequently does not yield a profit. The more an animal consumes, other things being equal, the more profitable gains he will make. Although the cost of feed was not so great, "Harry's" size and condition kept him from being worth as much per hundred pounds as "Tom" and "Dick." While "Tom" and "Dick" were valued at $7.95 and $7.90, respectively, "Harry" was valued at $7.00, and while he made a total gain during the 180 days of 94.5 pounds, "Tom" and "Dick" gained 305.5 and 250 pounds, respectively, in the same period of time.

The following table shows the cost, market value and profit at the close of the 180-day test:

TABLE IV.

FINANCIAL STATEMENT.

| | "TOM." | "DICK." | "HARRY." |
|---|---|---|---|
| Fort Worth market value April 1, 1915 | $ 1.47 | $ 1.62 | $1.83 |
| Cost of feed | 10.89 | 11.62 | 4.89 |
| Cost of care, 45 hours at 15 cents per hour | 2.25 | 2.25 | 2.25 |
| Total cost | $14.61 | $15.49 | $8.97 |
| Fort Worth market value September 28, 1915 | $26.23 | $21.88 | $8.75 |
| Profit | $11.62 | $ 6.39 | $ .22 loss. |

It is true that the feed bill was higher in the cases of "Tom" and "Dick," but the average daily gains show that it was used for gains instead of maintenance. The average daily gain for "Harry" was only .52 pound, while for "Dick" the gain was 1.38 pounds and "Tom" 1.697 pounds daily.

The value of manure from hogs is usually estimated to cover the cost of care, but in this case a record of the time used in feeding and caring for the pigs was kept and found to average 15 minutes a day. At 15 cents an hour this cost would amount to $2.25 per pig for the 180 days. Although the manure is very high in fertilizing constituents, its value is difficult to estimate with growing pigs getting different kinds and amounts of feeds; hence no value was placed on the manure here.

While this test does not furnish evidence from which conclusions can be drawn, these three pigs present a picture that should remain in the minds of everyone who sees, or reads of, them. It also indicates the results that should be expected, namely, that a balanced ration pays.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 10, NEW SERIES DECEMBER, 1915

# Housing Farm Implements

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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1916

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TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 10, NEW SERIES DECEMBER, 1915

# Housing Farm Implements

BY

B. YOUNGBLOOD, Director

AND

W. W. WHIPKEY, Architect

SUPERSEDING CIRCULAR NO. 4, NEW SERIES

POSTOFFICE:

COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

# HOUSING FARM IMPLEMENTS.

BY

B. YOUNGBLOOD, Director,

AND

W. W. WHIPKEY, Architect.

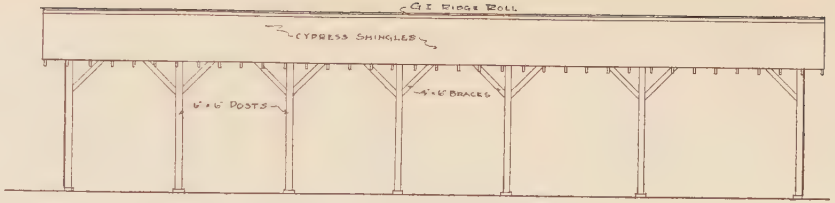
Good materials and labor should not be converted into an implement shed until a thoroughly satisfactory plan has been decided upon. We have observed implement sheds throughout the country a great deal during the past ten years, and it seems that most of them have been built first and planned later. Needless to say, the man who "builds in haste repents at leisure."

An implement shed should not be expensively built. Whenever it is so large and expensive that depreciation becomes as great as the amount saved by housing the implements, the investment comes to naught. The only way to make an implement shed a profitable enterprise, therefore, is to build it so economically and yet so permanently that depreciation on the shed itself is of minor importance as compared with the saving brought about by housing the implements.

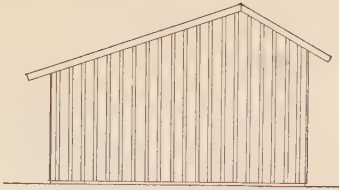
## LOCATION.

The location of the implement shed is an important matter. It should not be located where it is in the way. It should be conveniently located with reference to roadways leading to the fields and to the barn and lots in which work stock is kept. It should not be attached to the barn, for several reasons. The space about the barn is needed for horse lots. It is dangerous to both animals and implements for horses and mules to have access to the implements. Then there is the matter of fire protection. There should be a blacksmith shop in or preferably near the implement shed, and *not* near the barn. Obviously the chances for a total loss of barn, implement shed and contents are greatly reduced if the shed is located fifty feet or more from the barn. The principal reason for the big many-purpose barns found in the North is a matter of climate. Where the cold is intense a man prefers to have everything under one roof and so arranged that he may not be exposed to the weather in doing the chores. Where the winters are mild it is considered better to have special-purpose buildings, conveniently located with reference to one another.

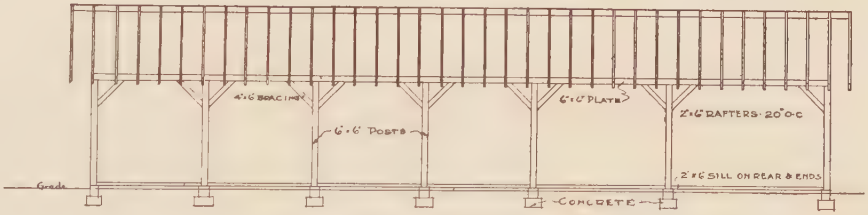
A few farmers have built implement barns, with big hallways down the center. These are too expensive and inconvenient. There is a big waste of space in the hallway and still it is usually difficult to get an implement out of the barn.



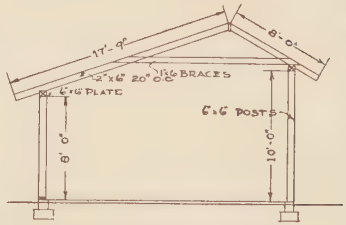

-FRONT ELEVATION-



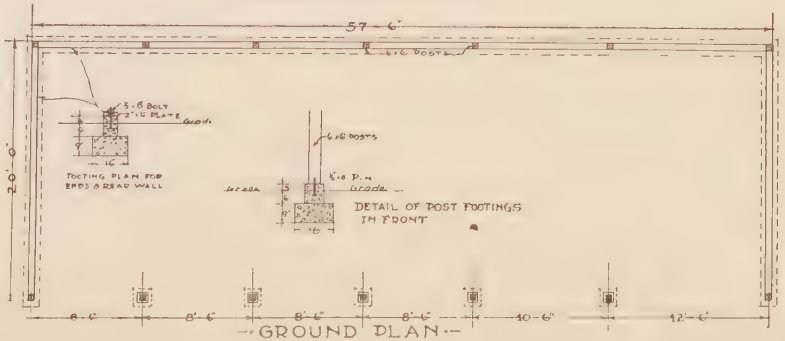
END ELEVATION




LONGITUDINAL SECTION




TRANSVERSE SECTION




-GROUND PLAN-

# THE LEAST EXPENSIVE AND MOST CONVENIENT TYPE OF PERMANENT IMPLEMENT SHED FOR TEXAS FARMS

TEXAS AGRICULTURAL EXPERIMENT STATION
B. YOUNGBLOOD - DIRECTOR
COLLEGE - STATION - TEXAS
W.W. WHIPKEY - ARCHITECT.

## THE BEST TYPE.

The least expensive and most convenient type of implement shed for Texas conditions is shown herein. It is constructed long and relatively shallow with one side left open so that the implements may be gotten in or out as needed without inconvenience. It is sufficiently deep to adequately protect the implements ordinarily used on the average farm. On farms where large pieces of farm machinery, as for instance threshing machines and traction engines, are kept, specially constructed sheds should be built, off to themselves.

It is not intended that these plans shall be followed blindly, but that they should be modified to suit the particular purposes of a given farm. On a small farm the depth may be reduced from 20 to 18 feet and the length made just sufficient to cover the implements kept on the farm.

For permanency, a continuous foundation of concrete on three sides is desirable, especially if the shed is to be constructed on a hillside. The shed can be constructed, however, at considerably less expense if concrete piers are used instead of the continuous foundation. The only change in plans would be to use a 4 x 6 instead of a 2 x 6 on top of the piers. The implement shed could be bolted down to the foundation regardless of whether piers or continuous foundation is used. If the material for making concrete is not available, then the next best thing to use is Bois d'Arc blocks. If these are not available, oak blocks treated with tar, asphalt or creosote will serve the purpose. It is cheaper in the end, however, to build permanently rather than temporarily. One should simply build the best he can, remembering that it is expensive to build either too cheaply or too elaborately.

The bill of materials calls for new lumber and the prices quoted are current here, but oftentimes second-hand material can be had and used at a great reduction in cost.

Concrete may be contracted for at the prevailing price of eight dollars a cubic yard completed. This may be reduced greatly by the farmer doing his own work, and where sand and gravel are available on the farm the cost will be further reduced.

There are left four spaces eight feet and six inches, one space ten feet and six inches, and another twelve feet and six inches, between front posts; the last two wider than the first four, in order that wide-tread implements, such as sulky hay rakes, may be backed into or pulled out of the shed with ease.

The plans herein given and the bills of material quoted were prepared by Mr. W. W. Whipkey, Architect for the Station, who has had excellent training and good practical experience.

This type of implement shed may be found on several of our sub-station experiment farms here and there over the State, where they are proving highly satisfactory.

Blueprints will be sent to persons ready to build, upon application to the Director.

Perspective view of the implement shed.

BILL OF MATERIALS FOR IMPLEMENT SHED 57½ FEET LONG AND 20 FEET WIDE, WITH TWO-FOOT OVERHANG ROOF.

| *Lumber.* | No. board feet |
|---|---|
| 5 pcs. 2 x 6 x 20, end and back sills | 100 |
| 3 pcs. 2 x 6 x 20, ridge pole | 60 |
| 37 pcs. 2 x 6 x 18, rear rafters | 666 |
| 37 pcs. 2 x 6 x 8, front rafters | 296 |
| 7 pcs. 6 x 6 x 10, front posts | 210 |
| 7 pcs. 6 x 6 x 8, rear posts | 168 |
| 5 pcs. 6 x 6 x 20, rear and end plates | 300 |
| 2 pcs. 4 x 6 x 16, post bracing | 64 |
| 8 pcs. 2 x 4 x 20, end and rear wall bracing | 107 |
| 108 pcs. 1 x 4 x 20, roof sheeting | 720 |
| 58 pcs. 1 x 12 x 8, rear wall boxing | 464 |
| 57 pcs. 1 x 4 x 8, rear wall battens | 152 |
| 35 pcs. 1 x 6 x 14, roof bracing | 245 |
| 26 pcs. 1 x 12 x 14, end wall boxing | 364 |
| 16 pcs. 1 x 12 x 12, end wall boxing | 192 |
| 26 pcs. 1 x 4 x 14, end wall battens | 122 |
| 16 pcs. 1 x 4 x 12, end wall battens | 64 |
| 200 feet 1 x 6, facia board | 100 |
| Total | 4394 |

To 4394 board feet lumber @ $25.00 per thousand feet ..... $109.85

*Other Materials.*

| | |
|---|---|
| 60 feet of ridge roll @ 8 cents per foot | $ 4.80 |
| 200 pounds nails @ $3.25 per 100 pounds | 6.50 |
| 15,000 prime cypress shingles @ $4.00 per thousand | 60.00 |
| 20 one-half-inch by eight-inch bolts @ 5 cents each | 1.00 |
| Total | $72.30 |

*Foundations.*

Continuous concrete end and rear walls and front piers:

| | |
|---|---|
| 25 sacks cement @ 60 cents per sack | $15.00 |
| 9 cubic yards gravel and sand @ $2.00 per yard | 18.00 |
| Total | $33.00 |

*Concrete Piers.*

16 piers 8 x 8 x 18 inches high:

| | |
|---|---|
| 6 sacks cement @ 60 cents per sack | $ 3.60 |
| 2½ cubic yards gravel and sand @ $2.00 | 5.00 |
| Total | $ 8.60 |

*Bois D'Arc Blocks.*

16 blocks eight inches in diameter and
24 inches long @ 25 cents each.....$ 4.00

---

The following figures show the total cost of the implement shed, using either of the three types of foundation:

USING CONTINUOUS CONCRETE FOUNDATION.

| | |
|---|---|
| Lumber | $109.85 |
| Other materials | 72.30 |
| Foundation | 33.00 |
| | $215.15 |

USING CONCRETE PIER FOUNDATION.

| | |
|---|---|
| Lumber | $109.85 |
| Other materials | 72.30 |
| Foundation | 8.60 |
| | $190.75 |

USING BOIS D'ARC BLOCKS.

| | |
|---|---|
| Lumber | $109.85 |
| Other materials | 72.30 |
| Foundation | 4.00 |
| | $186.15 |

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 12, NEW SERIES MARCH, 1916

DIVISION OF FEED CONTROL SERVICE

# Progress in Peanut Milling

POSTOFFICE
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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1916

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TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 12, NEW SERIES MARCH, 1916

DIVISION OF FEED CONTROL SERVICE

# Progress in Peanut Milling

BY

T. B. REESE

Feed Inspector

POSTOFFICE

COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

# PROGRESS IN PEANUT MILLING.

By T. B. Reese, Feed Inspector.

The milling of peanuts for the oil and cake is still in the experimental stage. Some tests have, in a measure, proved satisfactory, while others have resulted negatively. Four different methods have, so far, been tested by the mills, and have been modified according to the individual ideas of the various millers, as would naturally be expected in an industry that is just beginning.

It is hoped that with a little more experience the millers will perfect the methods of milling and, where necessary, make modifications in the machinery, so that within a very few years the manufacture of peanut products will be as commonly practiced as the manufacture of cottonseed products. If this is accomplished the South will have another feed and food supply which will make it less necessary that the farmers plant their land to cotton, and thus another step forward will be taken in practical diversification.

## FIRST METHOD.

The first method is the *cold press process.* The peanuts are cleaned as nearly as practicable of all sand, pebbles, and so forth, by means of screens and shakers, and then the peanuts, hulls, sticks, and all, are put through an ordinary Anderson expeller. By this method there are obtained about 62 gallons of a good grade of oil, weighing approximately 465 pounds, and about 1300 pounds of whole-pressed peanut cake. The remainder, two to three hundred pounds of dirt, pebbles, and so forth, per ton of farmers stock of peanuts, is waste.

This method does not seem to be practical for general milling, especially when the price of peanuts is very high, but it might be used to take care of the by-products of the shelling industry.

## SECOND METHOD.

The second method is one that shelling and grading concerns employ when they desire to dispose of that part of the product that is ordinarily unsalable, such as cracked or broken kernels and faulty, discolored, or immature, peanuts. The peanuts are prepared in the shelling plant and reach the mill practically free from hulls and foreign substances. They are passed over the rolls and run into the cookers, where they are subjected to about half the heat and pressure that are ordinarily used on cottonseed meats. But it is to be remembered that there is danger of over-cooking. From the cookers the meats are worked into the hydraulic presses in the way that cotton seed are, except that better

results are obtained with smaller cakes. The pressure is applied for about thirty minutes, a maximum of 4000 pounds being used. By this process there are obtained from a ton of the prepared product from 60 to 70 gallons of oil, about 550 pounds. The remainder, of course, is cake. Allowing some loss for moisture driven off in cooking, we should find about 1400 pounds of cake left. This cake is of bright gray color, free from grit, and low in crude fiber, and on analysis shows from 50 to 55 per cent. of protein and fat combined.

### THIRD METHOD.

The third and fourth methods are alike, in that the regular cotton oil mill machinery is used throughout, with certain adaptations, and differ only in the matter of cleaning, separation, and extraction. These processes are the results of efforts to use peanuts for practical oil milling purposes.

Manufacturers using the third method mill about as follows: The peanuts are unloaded into a perforated conveyor and carried to the seed-house. The regular cottonseed cleaning machinery is used to remove sand, sticks and foreign substances. From the cleaning machinery the nuts are passed to the first huller, where a coarse "cut" is made. Disk hullers are used. The first cut product is passed over a double shaker, the top screen of which has perforations large enough to allow whole peanuts to go through. The shells, or hulls, and large sticks that fail to fall through this screen are taken off by suction at the foot of the shaker and burned. The meats that fall through the second screen, which has a finer perforation, are passed to the rolls, while the product that passes over the second screen is put through the second huller, where a very fine cut is made. A separation similar to that from the first huller is obtained on a double shaker following this huller. Then the finishing shaker is used in an effort to remove the stringy fiber that comes from the web-like covering of the peanut, together with other fibrous matter. Then all of the product is ready for the rolls. The disadvantages of this method of separation are:

1. It is very difficult to remove all of the sand and pebbles.

2. There is a great wear on the disks of the hullers, due to the tough, fibrous nature of the peanut shell. The disks are dulled, and consequently start the oil to flowing, or crush the nuts before separation is completed.

3. There is a tendency on the part of the meats to "gum up" in the hullers and to "ball up" on the shakers.

4. The feeding is slow and irregular, and it is consequently difficult to get a proper cut in the huller, and an even run over the shakers.

From the separating machinery the meats are passed through the rolls and into the cookers. In cooking peanuts about half the heat is used as is ordinarily used in cooking cottonseed; also, about one-half as much pressure is applied. There is danger of over-cooking. The cooked meats are put into the presses in ten-pound cakes, usually, and the pressure is applied more slowly and the presses are left up longer

than in the case of cottonseed. They are subjected to a pressure of 4000 pounds for about thirty minutes. A difficulty often met with is that known as "spurting." The consequences of this are a wear on the press cloths, a large number of "loose ends" of cakes, and poor extraction. The daily tonnage of peanuts worked by this method is about half that of cottonseed, under ordinary milling conditions. When this method of milling peanuts is employed the miller obtains from a ton of farmers stock of peanuts an amount of oil varying from 65 to 75 gallons,—about 540 pounds,—and an amount of cake varying from 1000 to 1200 pounds. It will thus been seen that there is a loss in sand, sticks, and so forth, of from two to three hundred pounds. The oil is of a good quality, keeps well, and refines easily. The cake is of a dark gray color and has some grit in it. It keeps exceptionally well, however, when stored. On analysis the cake shows approximately 47 per cent. of protein and fat combined, and about 7 per cent. of fat and 20 per cent. of crude fiber.

FOURTH METHOD.

The fourth method is better than the third for cleaning and separating, but is not as good for extracting the oil. The process is about as follows: The peanuts are unloaded into a conveyor, and after traveling ten feet reach a cutflight conveyor, which is perforated for fifteen feet from the intake point. Then the ordinary perforated conveyor carries them twenty-five feet further into the seedhouse. This working removes the greater part of the sand and sticks. From the seed house the nuts are worked through a perforated conveyor to the sand reel, a distance of fifty feet or more. Up to this time the loss is from 10 to 15 per cent. in sand, sticks, and so forth. A by-product, however, is saved from the second conveyor, which is an overhead one, and consists of sticks, stems, broken kernels with particles of meat which pass through the perforations in the conveyors. This by-product is worth about $35.00 a ton as hog feed. The peanuts are next passed through the sand reel, and go directly to the separating machinery without having a blast to touch them. From the sand reel there is obtained a product consisting of fine particles of meats, polish, and bran, which goes directly to the finishing shaker. Only one huller of the disk type is used in getting the separation, and a fairly fine cut is made on the peanut. The product of this cut is passed over a double shaker, the top screen of which has perforations large enough to allow half a nut to fall through, and all the product that comes from the top screen is worked by hand back through the beaters and the huller. The product that passes through the second screen goes directly to the rolls, while that which works over the second screen goes over a finishing shaker before it is ready for the rolls. If the product is dry and meal dust is flying, a small amount of moisture is added at the rolls. Eighty-five per cent. of the hulls go with the meats, but a much better extraction would be obtained if only 50 per cent. of the hulls were allowed in the cake, for, in that case not so much oil is absorbed in the hulls. Cooking is done

at a much lower temperature with less pressure than in the case of cottonseed. Ten- to twelve-pound cakes are made, and the pressure is about 4000 pounds. The presses are left up thirty minutes. No trouble is met with wear on the press cloths because of "spurting."

There is some complaint of a great wear on the disks in the huller, and also on the plates in the mill used for grinding the finished cake. The tonnage of peanuts that can be worked per day by this method is 50 to 60 per cent. of that of cottonseed. By this method there are produced from a ton of farmers stock of peanuts, 60 to 65 gallons of oil,—about 465 pounds,—and about 1200 pounds of cake. This cake is of a rich gray color, free from gritty matter, and very palatable. It analyzes about 35 per cent. of protein, 8 per cent. of fat, and 23 per cent. of crude fiber.

The following is a conservative statement of what is secured in money from a ton of peanuts:

The cost of milling peanuts at the present time is more than the cost of milling cottonseed. At the present time a ton of farmers stock, which includes from two to three hundred pounds of dirt, sticks, trash, and so forth, is had at about $55.00. The milling averages about 65 gallons of oil, and about 1200 pounds of whole-pressed peanut cake. As the oil is worth 75 cents a gallon and the cake $25.00 a ton, the miller received a total of about $64.00 a ton, or about $9.00 margin on a ton to cover interest on investment, cost of milling, wear and tear on machinery, and reward for his enterprise in experimenting with peanuts as a source of oil and whole-pressed peanut cake.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 13 MARCH, 1916

# The Green Bug or Spring Grain Aphis

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

A212-316-5m

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 13. MARCH, 1916

# The Green Bug or Spring Grain Aphis

BY

S. W. BILSING

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

## FOREWORD

During the latter part of the winter the Texas Station received numerous requests from farmers for an inspection of their fields with a view to determining the extent of infestation by the green bug or spring grain aphis.

In response to these requests the Station secured of the School of Agriculture, Agricultural and Mechanical College of Texas, the services of Acting Professor of Entomology S. W. Bilsing to visit the grain-growing sections of the State and report conditions. Mr. Bilsing made the trip of inspection and submitted a report. We take pleasure in publishing this report, which includes much valuable information concerning the green bug and methods of control.

B. YOUNGBLOOD,
Director.

# THE GREEN BUG OR SPRING GRAIN APHIS

(*Toxoptera graminum* Rond.)

By S. W. Bilsing.*

## DISTRIBUTION IN TEXAS.

During the latter part of January and the first part of February of this year the author made an investigation of the status of the green bug or spring grain aphis in the wheat-growing sections of Texas.

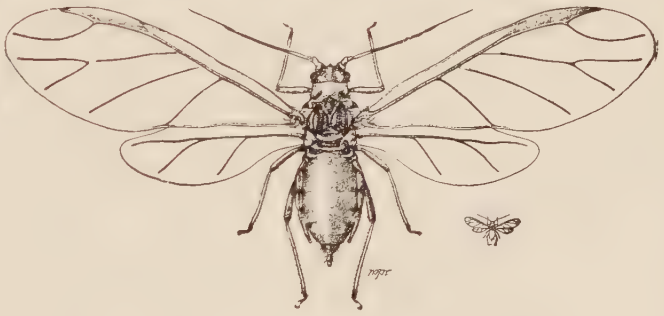

Figure 1—Winged viviparous female green bug.

Inspection was first made at Howe, Grayson County, from which point the first green bugs were reported early in December of 1915. Just previous to the inspection that part of the State was visited by heavy rains, which killed a great number of the green bugs. At Howe, however, both winged and wingless females were found. They were especially abundant in wheat fields in which volunteer oats had been allowed to grow early in the season. Wheat fields in which no volunteer oats or wheat had been allowed to grow were entirely free from green bugs, whereas adjacent fields containing volunteer oats and wheat were infested.

At Sherman about the same conditions were prevalent as at Howe. At both places green bugs were to be found only in wheat that had attained a considerable stand prior to the freezing weather that had occurred some days before the visit of the author. This weather had frozen the tops of the wheat and caused them to hang over the ground in such a way as to afford shelter to the bugs. In fields that had been sown late, or that had been pastured, very few or no bugs at all were

*Acting Professor of Entomology, Agricultural and Mechanical College of Texas, College Station, Texas.

to be found, although in many cases they had been reported as being in such fields a few days before. This seemed to indicate that they were able to survive the hard beating rains of a few days previous only where the wheat afforded sufficient protection.

At McKinney and Fort Worth,—both on the southern edge of the wheat belt,—no green bugs were found.

Early in the season they had become serious enough to destroy a few fields of oats in the vicinity of Denton, but the author was unable to find them there in very great numbers, and in some fields of late-sown wheat, where they had previously been reported in great numbers, only a few individuals were found.

Practically the same conditions prevailed at Celina, except that the green bugs were somewhat more abundant in wheat.

After the arrival of the author in Wichita Falls snow fell to a depth of about one inch. The next day some of it melted, and the following night the snow and water froze into a crust. The next day, upon removing cakes of this ice and snow, the author was able to find green bugs still alive. The temperature at Wichita Falls had fallen as low as zero on one occasion. While this temperature thinned their numbers considerably, many were still alive.

It was interesting to note that the insects were far more numerous at Winters than at Wichita Falls. At Winters they had destroyed some fields of oats completely and were more abundant than at any of the points previously visited. As severe weather had prevailed at Winters as at several of the other points, but there had been no rain.

The green bug or spring grain aphis, so far as is known, reproduces in Texas entirely by giving birth to living young. The following facts concerning the life history of this insect are taken from Bulletin 110, Bureau of Entomology, United States Department of Agriculture:

This insect feeds on a great variety of plants and so is able to perpetuate itself throughout the whole year in this State. It is generally believed that the dry, hot summers are unfavorable to it, and, in fact, in the past the most serious outbreaks seem to have occurred in years following a summer with heavy rainfall.

These insects begin to reproduce in from five to sixteen days after they are born in spring or summer, and in from twenty to twenty-seven days in colder weather. Mr. Urbahns of the Bureau of Entomology, United States Department of Agriculture, found that at Dallas, Texas, from March to the middle of May, the period varied from seven to twelve days from the time of birth to that of reproduction. From the middle of May to the last week of September, it varied from six to fourteen days; from the last week of September to November 3 it varied from nine to eleven days. From the beginning of April till November 3, in the vicinity of Dallas, the average time that elapsed between the birth of one generation and the reproduction of the next was 8.9 days. In the months of December and January the females continue to reproduce for an average of eight days. During April and May they continue to reproduce for an average of sixteen days. The

average period during which the females continue to reproduce for the whole season is 13.9 days.

The green bug lives longer during the spring and fall than during the summer.

In December and January the insect lives about thirty-four days. In April and May it lives about thirty-five days; in midsummer, from ten to thirty days; and in September, October, and November, the average is twenty-eight days. The average life for the whole season is twenty-six days.

The number of young produced by one individual varies considerably. The maximum number of young produced was 93, while the average for 216 individuals was 28. Since these insects commence to give birth to living young in a short time after they are born themselves, the progeny of a single pair in one season is almost beyond comprehension.

## NATURAL CONTROL METHODS.

The green bug is kept under control ordinarily by a small parasitic insect which resembles a minute wasp.* The parasite is active only when the temperature is above 56 degrees Fahrenheit, while the green

Figure 2—Parasite in act of parasitizing the green bug.
(From Webster.)

bug is active at a temperature as low as 40 degrees Fahrenheit. When the temperature is such that the green bug increases rapidly and the parasite is unable to multiply, there is a serious outbreak.

## PREVENTIVE MEASURES.

Volunteer oats and wheat make good breeding places for the green bug, and should, therefore, be destroyed as early in the season as possible. Some fields that had been seeded to wheat, in which volunteer oats had been allowed to grow, showed a heavy infestation, while fields in the immediate vicinity which had been resown in wheat only a few or no green bugs at all were found. It was also found that the infestation in late-sown fields and in those which had been pastured, was very light as compared to that in early-sown wheat.

Fields of late-sown wheat, which were heavily infested before the heavy rains of the latter part of January, were almost free from the

*_Lysiphlebus testaceipes_ Cress.

green bug after those rains. On the other hand, the early-sown wheat, whose tops had frozen over and afforded a shelter to the insect during the rains, were still heavily infested, although the number of green bugs had been somewhat reduced.

The heavy rains seem to have been a more efficient factor in the control of the green bug than was the cold weather. Localities in West Texas which had approximately the same conditions of temperature as localities in North Texas, but which had no rain, were much more severely infested, and in some places the oats had been entirely destroyed. These conditions indicate that early-sown wheat affords a good protection for the insect, and that the early sowing of wheat should be avoided if possible.

When only the wingless females occur, the damage is first confined to circular areas, which turn yellow in color. As the insects become more numerous they radiate out in all directions and constantly increase the size of the area. When these areas are first noticed they should be covered with straw and burned over. If it is not possible to cover them with straw they should be plowed and thoroughly harrowed.

Finally, emphasis should be given to the importance of the destruction of all volunteer wheat and oats in the early part of the season, and the burning over of infested areas when the bugs are confined to small areas. Some care in the future will tend to minimize the danger from this insect, if these points are kept in mind.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 14 MAY, 1916

DIVISION OF ENTOMOLOGY

# Foul Brood Regulations

Effective September 1, 1916

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

A229-516-5m

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 14 MAY, 1916

DIVISION OF ENTOMOLOGY

# Foul Brood Regulations

Effective September 1, 1916

(SUPPLEMENTAL TO CIRCULAR NO. 11)

F. B. PADDOCK, B. S. E.
State Entomologist

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS
1916

# FOUL BROOD REGULATIONS

Effective on and after September 1, 1916.

(Supplemental to Circular No. 11.)

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BY

F. B. PADDOCK, B. S. E., STATE ENTOMOLOGIST.

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## BOX HIVES.

It is hereby ordered that on and after September 1, 1916, the honey bees in *Comal, Falls, Fannin, Guadalupe, Hays, Leon* and *Ward* Counties shall be kept only in movable frame hives, permitting of ready examination. The keeping of bees in box hives, "gums," logs, barrels, or other domiciles, within these counties, is unlawful. Bees kept in any form of hive except one containing movable frames permitting of ready examination, within these counties, are subject to destruction by the county inspector at the owner's expense, as provided by Section 14 of the Foul Brood Law.

## COUNTY QUARANTINES.

*Regulation 24.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Comal County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Comal County whereby the bees, honey, appliances, or other things capable of transmitting foul brood, may be inspected immediately upon their arrival at destination.

*Regulation 25.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Falls County Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arangements may be made with the inspector of Falls County whereby the bees, honey, appliances, or other things capable of transmitting foul brood, may be inspected immediately upon their arrival at destination.

*Regulation 26.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Fannin

County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Fannin County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 27.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Guadalupe County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Guadalupe County whereby the bees, honey, appliances, or other things capable of transmitting foul brood, may be inspected immediately upon their arrival at destination.

*Regulation 28.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Hays County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the Inspector of Hays County whereby the bees, honey, appliances, or other things capable of transmitting foul brood, may be inspected immediately upon their arrival at destination.

*Regulation 29.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Leon County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Leon County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 30.*—No bees, honey, appliances, or other things capable of transmitting foul brood, shall be moved or shipped into Ward County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Ward County whereby the bees, honey, appliances,

or other things capable of transmitting foul brood, may be inspected immediately upon their arrival at destination.

Given under my hand and seal, at College Station, Texas, this 1st day of May, 1916.

F. B. Paddock

State Entomologist.

## COUNTY APIARY INSPECTORS

For Atascosa County—G. F. Davidson.....Pleasanton, Texas.
For Bee County—E. R. Jones.....Beeville, Texas.
For Bell County—R. E. Watson.....Heidenheimer, Texas.
For Bexar County—H. Grossenbacher.....San Antonio, Texas.
For Brazos County—F. B. Paddock.....College Station, Texas.
For Comal County—John Donegan.....Seguin, Texas.
For Delta County—Jas. W. Traylor.....Enloe, Texas.
For Ellis County—T. W. Burleson.....Waxahachie, Texas.
For Falls County—Dr. Geo. J. Elam.....Marlin, Texas.
For Fannin County—R. C. Abernathy.....Ladonia, Texas.
For Frio County—R. A. Little.....Pearsall, Texas.
For Goliad County—W. C. Collier.....Goliad, Texas.
For Guadalupe County—John Donegan.....Seguin, Texas.
For Hays County—John Donegan.....Seguin, Texas.
For Hunt County—W. H. White.....Greenville, Texas.
For Lamar County—E. W. Cothran.....Roxton, Texas.
For Leon County—W. P. Bankston.....Buffalo, Texas.
For McCulloch County—M. C. Stearns.....Brady, Texas.
For McLennan County—Dr. N. G. LeGear.....Waco, Texas.
For Medina County—H. L. Mofield.....Hondo, Texas.
For Milam County—A. R. Graham.....Milano, Texas.
For Refugio County—W. C. Collier.....Goliad, Texas.
For San Patricio County—Wm. Atchley.....Mathis, Texas.
For Uvalde County—S. H. Stephens.....Uvalde, Texas.
For Victoria County—M. B. Tally.....Victoria, Texas.
For Ward County—J. W. E. Basham.....Barstow, Texas.
For Wilson County—Victor Boeer.....Jourdanton, Texas.
For Zavala County—J. B. King.....Batesville, Texas.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 15 JUNE, 1916

# A Milk House for Texas

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

A237-5m-6-12-16

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 15 JUNE, 1916

# A Milk House for Texas

BY

LEROY RHODES

Assistant Professor of Agricultural Engineering
Agricultural and Mechanical College of Texas

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

# A MILK HOUSE FOR TEXAS

BY

LEROY RHODES*

The purpose of this circular is to present to the dairy farmers of Texas plans for a milk house to be built near the dairy barn, and sufficient in size to provide room for handling the milk from twenty or more cows.

The plans shown in this circular (Figure 1) consist of four drawings and a bill of materials. The first drawing shows half of the building as side elevation, and the other half as framing detail. The second drawing is an end view, showing the framing. The lower drawing shows the floor plan with the location of the various apparatus such as churn, aerator, separator, tester, washing vat, boiler, and fuel bin. At the right of the floor plan is shown a cross-section of the concrete foundation and floor. The location of the semi-circular drain should be noted in the last-mentioned drawing. In the upper corner at the right is shown a section of the wall at the point where the record sheet holder is attached. This drawing shows the construction details of the record sheet holder. A bill of materials is included, and by getting local prices a person who intends to build may make a fair estimate of cost.

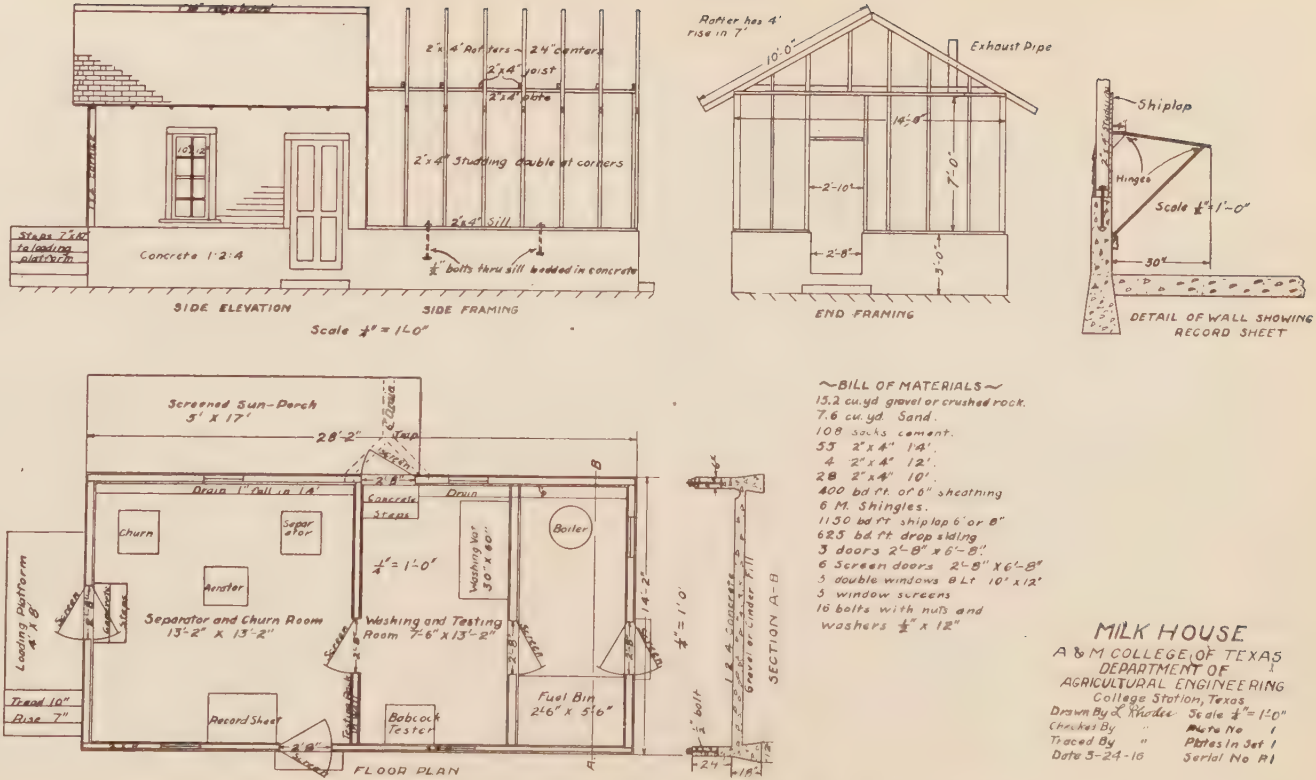
Three photographs were taken of the milk house now in use at the Feeding and Breeding Station, College Station, and are reproduced herein as Figures 2, 3 and 4. With the exception of a few details of arrangement on the inside, this house is the same as the one for which plans are shown herewith.

Figure 2 shows the relation between the milk house and the dairy barn in the background; also the loading platform on the end and the screened sun porch for hanging the milk utensils.

Figure 3 shows the other side of the house and its main entrance. The passageway between the barn and the milk house is shown covered. This is a great help in rainy weather, but is not essential. Two doors are shown in this view, but in the plans only one is used and should be sufficient for all purposes. These two figures will give the reader a pretty good idea of how the building will look when constructed. By referring to the plans as he reads, one should have no trouble in understanding the descriptions and explanations which follow.

The milk from each cow should be taken care of as soon as drawn and not left to stand in the bucket in the barn. To make this easy

*Assistant Professor of Agricultural Engineering, Agricultural and Mechanical College of Texas, College Station, Texas.




~BILL OF MATERIALS~

13.2 cu. yd gravel or crushed rock.
7.6 cu. yd Sand.
108 sacks cement.
55 2"x4" 14'.
4 2"x4" 12'.
28 2"x4" 10'.
400 bd ft. of 6" sheathing
6 M. Shingles.
1130 bd ft shiplap 6" or 8"
625 bd ft drop siding
3 doors 2'-8" x 6'-8".
6 Screen doors 2'-8" X6'-8"
3 double windows 8 Lt 10" x 12"
3 window screens
16 bolts with nuts and washers ½" x 12"

MILK HOUSE
A & M COLLEGE OF TEXAS
DEPARTMENT OF
AGRICULTURAL ENGINEERING
College Station, Texas

Drawn By L. Rhodes — Scale ½"= 1'-0"
Checked By ... — Plate No 1
Traced By " — Plates In Set 1
Date 5-24-16 — Serial No A1

Figure 1. Plans and Bill of Materials for Model Milk House for Texas.

the milk house should be located not further than twenty feet from the barn, and twelve or fifteen feet is better. The end of the house with the loading platform should face the south, as is shown in Figure 1. This allows the afternoon sun to strike the utensils hung in the screened porch. As is shown in Figure 2, the side door should be the one nearest the door of the dairy barn as the milk is most conveniently handled when brought in through this door. The milk scales should be located just inside this door near the record sheet, so that the weight of each cow's milk can be recorded as soon as taken. The detailed drawing in the upper right-hand corner shows the construction of the holder for the record sheet. The sheet is tacked to this holder, which is hinged at the wall so that it may be folded back out of the way when one is scrubbing the floor or doing other work in the room. This arrangement also prevents the accumulation of dust

Figure 2. Side View of Milk House, Showing Screened Sun Porch.

on the sheet when not in use. Just to the right of the door as one enters is a rack with several shelves built in the wall and open to both the separating room and the testing room. After the milk is brought in and its weight recorded, a sample is taken for testing. The sample bottle is put on one of the shelves of the rack and when all the milk has been taken care of the samples are taken from the other side of the rack and tested together.

The aerator, churn and separator are shown in what is thought to be the best positions. This arrangement, however, may be varied to suit individual preference. With the arrangement as shown the steam is piped by the shortest distance from the boiler to the washing vat and to the turbine of the separator. A steam pipe is also carried across to the tester to furnish steam for its operation. The exhaust steam is carried out through the pipe extending through the roof, as shown in the end framing view.

The dimensions of the loading platform are shown to be four by eight feet. If it is desired to load the cans into the wagon at the rear, this platform may be made four feet square, so that the rear wheels of the wagon will straddle it.

Figure 3. End View of Milk House, Showing Unloading Platform.

Figure 4. General View of Milk House and Dairy Barn.

Either shingles or prepared roofing may be used on the roof. If the prepared roofing is used, the sheathing must be laid tight.

It is intended in the plans shown to cover the inside of the building with shiplap laid horizontally. If it is carefully put on, there should be no trouble from water splashing and entering the cracks.

If desired, however, the shiplap may be put on vertically. The concrete extends two feet above the floor and this should be sufficient to take care of all splashing when one is scrubbing the floor.

One should take great care in building the concrete forms, and in mixing and finishing the concrete. The forms should be well braced to prevent bulging and should be made of smooth boards. By churning the concrete with a spade or thin paddle just after it is poured, one can push back the crushed rock or gravel from the surface and thereby leave a smooth, compact finish, which is easily kept clean. The walls and foundation should be reinforced at the corners and the mixture should be wet enough to run. The proportions should be one part cement, two parts sand, and four parts gravel or crushed rock. Six inches is sufficient thickness for these walls if the 1:2:4 mixture is used. If a leaner mixture is used it will be necessary to makes the walls thicker. The floors should be finished smooth with the trowel and have a slope of one inch in fourteen feet toward the open drain at the back of the house. This drain is in two parts and slopes from each end of the building to the middle of the back side. The two drains empty separately, as the one in the separator room will, perhaps, be used more than the other. The two ends join at the trap, which should be six inches in diameter. This trap prevents gases from coming back through the title that leads the water away to the septic tank, if one is provided. If no septic tank is provided the outlet may be placed on a hillside, but not closer than 200 yards.

If desired, the drains may be carried through the building with gratings at the center of each room. In this case the floors should slope toward the gratings. It is thought that the drains are more easily cleaned and that there will be less danger of clogging, when constructed as shown in the floor plan. The drain at the right passes through the wall between the boiler room and washing room and then empties at the right of the concrete steps leading to the sun porch.

All doors and windows are screened, and special care should be taken to keep out flies. The boiler and fuel bin are located in a separate room, so that the dirt, which necessarily goes with the handling of fuel, will not reach the milk.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 16 JULY, 1916

DIVISION OF VETERINARY SCIENCE

# DIRECTIONS FOR PREPARATION OF VETERINARY SPECIMENS FOR EXAMINATION

POSTOFFICE:

COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
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TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 16 JULY, 1916

DIVISION OF VETERINARY SCIENCE

# DIRECTIONS FOR PREPARATION OF VETERINARY SPECIMENS FOR EXAMINATION

BY

M. FRANCIS, D. V. S.
Veterinarian in Charge
Dean School of Veterinary Medicine

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

# DIRECTIONS FOR PREPARATION OF VETERINARY SPECIMENS FOR EXAMINATION.

The Veterinary Department invites the citizens of the State to call on it whenever its services are needed. A great majority of the specimens that are sent in reach us in such a condition that satisfactory service is impossible. If the following directions for collecting the material are observed, we can give much more prompt and accurate results. As a great many relate to contagious diseases in which the blood is infected, the following directions for preparing samples of blood should be carefully followed:

*Blood Smears.*—These consist of a very thin layer of blood spread on the surface of a piece of glass, and dried. It is very convenient to

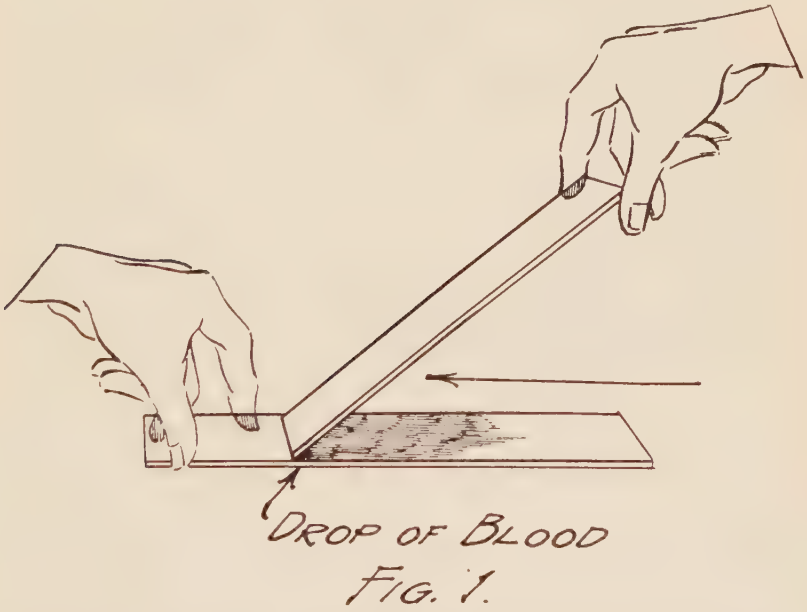


Fig. 1.

prepare these on pieces of glass, say, 1x3 inches and one-sixteenth inch thick. The glasses should be clean and warm. In emergencies, fragments of window glass will answer the purpose. The smear is made by placing a *small* drop of blood on a glass slide, and spreading it with another piece of glass that has a straight edge, so that the blood *follows* and dries quickly in a thin layer. (See Figure 1.) It may be easier for one having had no experience in this work to push the drop of blood *ahead* of the glass used as a "scraper." (See Figure 2.) Both methods yield satisfactory results after a few trials.

It is impossible for one to make good smears when the temperature is below, say, 80° F. To overcome this, we heat several building bricks on a stove, wrap them in newspapers and carry them to the sick animal. The glasses are laid on the bricks until they become blood warm and the blood smears will then become dried very quickly. In warm weather the dried smears must be put in boxes or otherwise protected from flies.

Please do not send us blood in a dirty bottle or a fruit jar, or put some of it between two pieces of glass and permit it to dry there, or split an Irish potato and enclose a few drops, because we cannot use such specimens with any degree of accuracy.

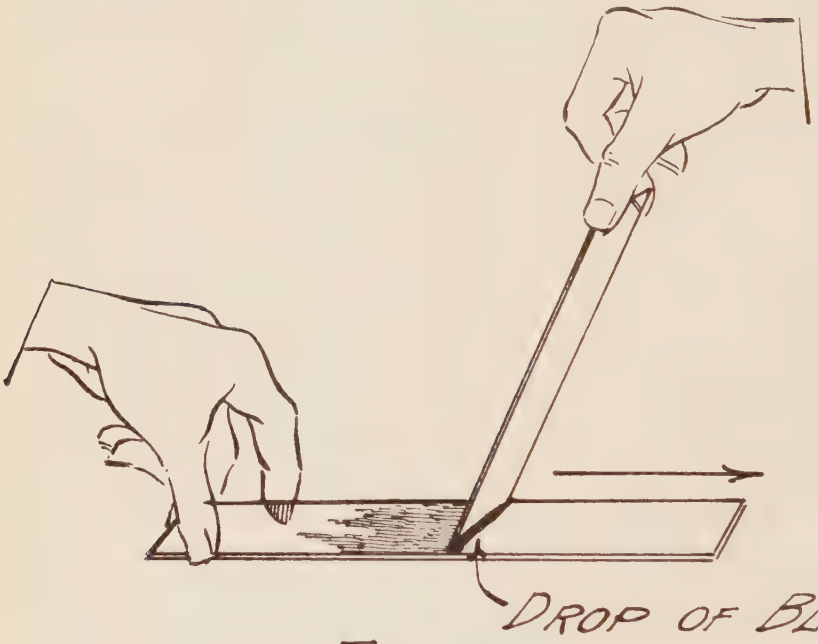


FIG. 2.

If it becomes necessary to send in a quantity of blood, obtain a hypodermic syringe, put it in a basin of cold water and heat it until the water has boiled five to ten minutes. This will sterilize it. Remove the basin from the fire, and wait for the water to cool to blood heat. Then fill the syringe with blood and forward it, with its needle, to us; we will return it to you. If the animal is alive, shave the hair off the jugular vein, tie a strong hemp cord around the neck so that the vein will fill with blood, then fill the syringe directly from the vein. If the animal has been dead only a short time, say, an hour or so, the syringe may be filled from the heart. If the animal has been dead several hours, it is generally useless to attempt to collect samples of blood because by this time it has become contaminated with bacteria from the bowels.

If no syringe is at hand, cut off an ear, *close to the head,* and send it to us. We usually can find enough blood in the ear to make laboratory tests.

ANTHRAX.

If anthrax is suspected as the cause of death, make several blood smears on pieces of glass or draw a small quantity of blood directly from the vein into a sterile syringe, and then send the syringe and its needle to us, or cut off an ear close to the head, wrap it in sterile gauze and forward it. Having done so, wash your hands with great care before eating any food, putting your fingers in your mouth, or using the hands for any purpose.

BLACKLEG.

With a clean sterile knife, cut an ounce or so of the black, frothy flesh and put it at once in a clean, sterile wide-mouthed bottle.

TEXAS FEVER.

Make blood smears from the heart-muscle, spleen and kidney, immediately after death and send them to us for microscopic examination.

TUBERCULOSIS.

The detection of tuberculosis in blood and milk is a difficult matter. Smears, on *thin* cover glasses, may be made for *young* tumors of tuberculosis, but old abscesses seldom yield material for a positive test. It is usually best to test the living animal with tuberculin. (See Farmers' Bulletin No. 351.)

HOG CHOLERA.

It is usually best to send us one of the sick pigs or one that has just died.

GLANDERS.

It is usually best to test the living animal with mallein. If the guinea pig test be desired, make a swab by taking a piece of wire, say, eight inches long, and wrapping a piece of absorbent cotton on one end of it. Place this in a glass tube, and plug the neck of the tube with cotton. Sterilize by dry heat for fifteen minutes or more, until you notice the cotton turn yellow in color. When it has cooled, pass the swab on the wire up to the end of the horse's nostril, revolve so as to collect the desired material, and immediately replace the swab in the glass tube.

If farcy be suspected, shave the hair off one of the buds, open it with a clean, sterile knife, and collect some of the discharge on a cotton swab, prepared as above directed. (See Figure 4.)

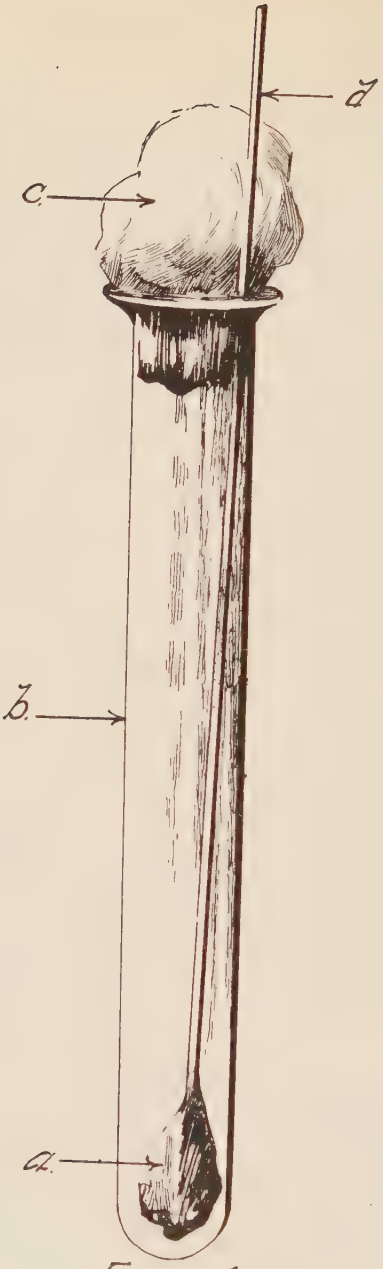


FIG. 4.

a.— COTTON SWAB.
b.— TEST TUBE.
c.— COTTON PLUG.
d.— WIRE.

### RABIES.

Examinations for rabies are not made at College Station. If an animal be suspected of having rabies, confine it in a cage from which escape is impossible, and await developments. If it dies, cut the head off about half way between the ears and shoulders, place it in a clean metal vessel, and pack this in a wooden box surrounded by chipped ice, and forward it to the Pasteur Institute at Austin, Texas. If people have been bitten by a dog suspected of having rabies, it is best that they go at once to Austin to consult experts there. Waste no time on the so-called "mad-stones."

### MILK.

Fit several small bottles with corks and boil them for ten minutes in a vessel of water. The corks must be held under the water with forceps or fixed on hatpins.

When they have cooled to blood heat, wash your hands and the teats of the cow with great care; then milk from the diseased teats directly into the bottles. Insert the stopper without touching it with the fingers. Label the bottles so they can be identified. These milk samples should be secured by milking the cow in the open air and not in any building.

### SKIN DISEASES.

Skin diseases due to fungi, such as "ring-worm," are usually easily diagnosed by examination of scrapings taken from the margin of the "ring." These may be collected in an ordinary envelope.

If "itch-mites" are suspected, put the scabs in a small bottle, because the mites often leave the scabs and we are unable to find them, if envelopes be used.

Address all shipments to the Veterinary Department, College Station, Texas.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 17 NOVEMBER, 1916

DIVISION OF ENTOMOLOGY

# THE TEXAS FOUL BROOD LAW

AND

# FOUL BROOD REGULATIONS

SUPERSEDING CIRCULARS NO. 8, 11, 14

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TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 17 NOVEMBER, 1916

DIVISION OF ENTOMOLOGY

# THE TEXAS FOUL BROOD LAW

AND

# FOUL BROOD REGULATIONS

BY

F. B. PADDOCK, M. S.
Entomologist in Charge; State Entomologist

SUPERSEDING CIRCULARS NO. 8, 11, 14

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

AUSTIN, TEXAS
VON BOECKMANN-JONES CO., PRINTERS
1916

# THE TEXAS FOUL BROOD LAW.

BY F. B. PADDOCK, M. S., ENTOMOLOGIST IN CHARGE; STATE ENTOMOLOGIST.

The present foul brood law of Texas was enacted by the Thirty-third Legislature, approved March 27, 1914, and became a law ninety days later. It embodies many advantages over the previous law.

The Entomologist in Charge, Division of Entomology, Texas Agricultural Experiment Station, is named in the law as the State Entomologist who is charged with the enforcement of the law.

General Laws of Texas, Thirty-third Legislature.

(H. B. No. 11.) CHAPTER 51.

An Act to amend Chapter CXXVI of the Acts of the Regular Session of the Twenty-eighth Legislature, entitled "An Act to provide for the protection of honey bees against foul brood and other contagious diseases, and providing that all beekeepers report to the State Entomologist when infectious diseases exist; providing for collecting the expense of eradicating the disease, and fixing the charges upon the owner or agent of the bees; providing for the extermination of all contagious diseases; and providing penalties for the violation of any of the provisions of this Act," and declaring an emergency.

*Be it enacted by the Legislature of the State of Texas:*

Section 1. That Chapter CXXVI of the Acts of the Regular Session of the Twenty-eighth Legislature be, and the same is, hereby amended so as to hereafter read as follows:

Section 2. That for the purpose of carrying out the provisions of this Act, the Entomologist of the Agricultural Experiment Station of the Agricultural and Mechanical College of Texas shall be the State Entomologist of this State, and as such it shall be his duty to enforce the provisions of this Act and to issue such rules, regulations, etc., as are hereinafter required. As State Entomologist he shall receive no fees or remunerations other than his regular salary as Entomologist of the Experiment Station and State Entomologist; provided, that he may be reimbursed for necessary expenses incurred in discharge of his duties as State Entomologist. He shall employ such assistants and inspectors as may be necessary, subject to the approval and confirmation of the Director and Governing Board of the Texas Agricultural Experiment Station. He shall make an annual report to the Director and Governing Board of the Experiment Station, such report giving a detailed account of all funds received and disbursed, and for what purpose, as

well as a full report upon all prosecutions, etc., made under the provisions of this Act.

Section 3. The said State Entomologist shall have full and plenary power to deal with all contagious or infectious diseases of honey bees which, in his opinion, may be prevented, controlled or eradicated; and shall have full power and authority to make, promulgate and enforce such rules, ordinances, orders and regulations, and to do and perform such acts as, in his judgment, may be necessary to control, eradicate or prevent the introduction, spread or dissemination of any and all contagious diseases of honey bees as far as may be possible, and all the rules, ordinances, orders and regulations of said State Entomologist shall have the force and effect of the law in so far as they conform to the general laws of this State and the United States. The State Entomologist, in the exercise of the power and authority herein delegated, shall have authority to prohibit the shipment or bringing into this State of any honey bees, honey, honey-comb, or articles or things capable of transmitting contagious or infectious diseases of bees, from any State, Territory or foreign country, except under such rules and regulations as may be adopted and promulgated by said State Entomologist.

Section 4. All honey bees shipped or moved into this State shall be accompanied by a certificate of inspection signed by the State Entomologist or State Foul Brood Inspector of the State or country from which shipped. Such certificates shall certify to the apparent freedom of the bees, and their combs and hives, from contagious and infectious diseases and must be based upon an actual inspection of the bees themselves within a period of sixty days preceding date of shipment. The shipper of such bees is hereby required to file with the State Entomologist at College Station, Texas, at least ten days in advance of such shipment, a certified copy of said certificate, together with the names and addresses of both consignor and consignee; provided, that when honey bees are to be shipped into this State from other States or countries wherein no official apiary inspector or State entomologist is available, the State Entomologist of Texas may issue permit for such shipment upon presentation of suitable evidence showing such bees to be free from diseases. Shipments of bees arriving at points within this State, not accompanied by the certificate herein described, shall be subject to confiscation and destruction by the State Entomologist or his assistants. This requirement shall not apply to shipments of live bees in wire cages, when without combs or honey.

Section 5. It shall be unlawful for railroad companies, express companies or other common carriers to accept for shipment, between points within this State, any honey bees, used honey combs, used bee hives or fixtures, except under such regulations and provisions as the State Entomologist shall prescribe.

Section 6. The State Entomologist, through himself, assistants or inspectors, shall have authority to seize and confiscate any shipments of diseased bees found in transit in this State, or found in any depot, express office, storeroom, car, warehouse or premises awaiting transpor-

tation or delivery, and the State Entomologist, through himself or assistants, shall have authority to enter, during ordinary business hours, any depot, express office, storeroom, car, warehouse, or premises for the purpose of inspecting any shipment of honey bees therein which he may have reason to believe are or may be infected with a contagious or infectious disease or which he may have reason to believe are being transported or have been or are about to be transported in violation of any of the provisions of this Act.

Section 7. In the discharge of the duties herein delegated the State Entomologist, and his assistants and inspectors, shall have authority to enter, during ordinary business hours, any premises, public or private, wherein may be located any honey bees, or wherein he or they may have reason to believe any honey bees are kept or located, for the purpose of examining said bees and determining whether or not they are infected with any contagious or infectious disease.

Section 8. The State Entomologist shall have authority to declare a protective quarantine in any district, county, precinct or other defined area wherein foul brood or other contagious disease of bees is not known to exist, or wherein any disease of bees is being eradicated in accordance with the provisions of this Act, said quarantine to prohibit the movement or shipment, into said district, county, precinct or other area, of any bees, honey, appliances or other things capable of transmitting the disease or infection, except under such rules and regulations as he shall prescribe.

Section 9. The State Entomologist shall have authority when, in his opinion, public welfare and necessity require it, to place a restrictive quarantine upon any district, county, precinct, or other defined area wherein are located any honey bees infected with contagious or infectious disease, said quarantine to prohibit the movement or shipment therefrom of any bees, honey, appliances or other things capable of transmitting the infection, except under such rules and regulations as he shall prescribe.

Section 10. Queen bees and their attendant bees shall not be sold or offered for sale in this State unless accompanied by a copy of a certificate from a State or government entomologist or apiary inspector to the effect that the apiary from which said queen bees are shipped has been inspected within the preceding twelve months and found apparently free from contagious and infectious diseases, or by a copy of a statement by the beekeeper made before a notary public or other officer having a seal that the bees are not diseased to the best belief of affiant, and that the honey used in making the candy contained in the queen cage has been diluted and boiled for at least thirty minutes in a closed vessel.

Section 11. Any person, firm or corporation violating any of the provisions of this Act, or violating any of the rules, quarantines, orders or regulations of the State Entomologist issued in accordance with the provisions of this Act, shall be deemed guilty of a misdemeanor, and shall, upon conviction thereof, be fined in any sum not less than twenty-

five nor more than two hundred dollars. All prosecutions under this Act shall be commenced and carried on in any county of the State affected by the violation of said orders, quarantines, rules or regulations, and the said State Entomologist may enjoin any threatened or attempted violation of his orders, quarantines, rules or regulations in any court of competent jurisdiction, or take any other civil proceedings necessary to carry out and enforce the provisions of this Act. It shall be the duty of the Attorney General and the various county and district attorneys to represent said State Entomologist, whenever called on to do so; and said State Entomologist, in the discharge and enforcement of the duties and powers herein delegated, shall have the authority to compel the production for examination by said State Entomologist, or anyone designated by him, of all books, papers and documents in the possession of any person; to take testimony, and compel the attendance and examination under oath of witnesses; and it is hereby made the duty of the various sheriffs and constables throughout the State to serve all papers, orders, summons and writs that may be delivered to them by said State Entomologist and to protect the State Entomologist or his assistants or inspectors in the discharge of their duties, as herein defined whenever called upon to do so. The State Entomologist is authorized when necessary to apply to any court of competent jurisdiction for the necessary writs and orders to enforce the provisions of this article, and in such cases he shall not be required to give bond.

Section 12. For the purpose of disseminating knowledge regarding honey bees and their diseases, the State Entomologist shall publish methods and directions for treating, eradicating or suppressing contagious or infectious diseases of honey bees, including the rules and regulations provided for in Sections 2, 3, 5, 8, and 9, and such other information as he shall deem of value or necessity to the beekeeping interests of the State.

Section 13. If any owner of, or person having control or possession of any honey bees in this State, knows that any bees so owned and controlled are affected with American foul brood, or any other contagious or infectious disease, or knows of any other bees so diseased, it shall be and is hereby made his duty to at once report such fact to the State Entomologist at College Station, Texas, setting out in his said report all the facts known with reference to said infection.

Section 14. The State Entomologist shall have full power in his discretion to order any owner or possessor of bees dwelling in hives without movable frames, or not permitting of ready examination, to transfer such bees to a movable frame hive within a specified time. In default of such transfer the State Entomologist may destroy, or order destroyed, such hives, together with the honey, frames, combs and bees contained therein, without recompense to the owner, lessee or agent thereof.

Section 15. If at any time the State Entomologist finds, or has reason to believe, that the owner or keeper of any bees, or the owner of any apiaries has refused or is refusing to comply with any or all of

the rules and regulations hereinbefore provided for, then and in that event the State Entomologist is hereby authorized to inspect or cause to be inspected said bees, and, if necessary, burn diseased colonies, appliances and honey, and do any and all things necessary in the premises to eradicate foul brood or any other contagious or infectious disease of bees.

Section 16. When any owner or possessor of bees shall fail to carry out the instructions of the State Entomologist as hereinbefore set forth, the State Entomologist, or his assistants or inspectors, shall carry out such destruction or treatment and shall present to the owner or possessor of said bees a bill for the actual cost of such destruction or treatment, including the cost of such hives, foundations, etc., as may be necessary for proper treatment of the disease. In the failure of the owner or possessor of such bees to pay said bill within thirty days after the delivery of same to himself, tenant or agent, or within thirty days after mailing same to his usual postoffice address, the State Entomologist shall certify to the county attorney of the county wherein such bees were located, the amount and items of such bill; and the county attorney shall file suit for the recovery of said account. All moneys recovered by the county attorney for such destruction or treatment shall be paid into the hands of the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 17. If any owner or keeper of any diseased colonies of bees shall barter, give away, sell, ship or move any infected bees, honey or appliances, or shall expose any other bees to the danger of infection of the disease, or shall refuse or neglect to make report as provided in Section 13 of this Act, he shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not less than twenty-five nor more than two hundred dollars.

Section 18. It shall be unlawful for any person, firm or corporation to expose, on their own premises or elsewhere, any honey, hives, frames, combs, brood or appliances known to be infected by foul brood or other dangerous disease of bees, in such a manner that honey bees may have access to same; and it shall be unlawful to sell, offer for sale, barter, give away, ship or distribute any honey taken from a colony or colonies of bees infected with foul brood or other infectious or contagious disease. Violation of this section shall be deemed a misdemeanor and any person, firm or corporation convicted thereof shall be fined in any sum not less than twenty-five nor more than two hundred dollars.

Section 19. Anyone who shall seek to prevent any inspection of bees, honey or appliances under the direction of the State Entomologist, in accordance with this Act, or who shall attempt to prevent the discovery or treatment of diseased honey bees, or who shall attempt to intimidate the State Entomologist, or his assistants or inspectors, or otherwise interfere with them in the lawful discharge of their duties as herein defined shall be deemed guilty of a misdemeanor, and shall, upon conviction, be fined in any sum not less than twenty-five nor more than two hundred dollars. Prosecutions under the provisions of this

section shall be instituted in any county of the State in which the offense is committed.

Section 20. All fines collected for prosecutions under the provisions of this Act shall be paid to the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 21. The State Entomologist, his assistants and inspectors, shall not be required to give bond or security in any legal proceedings which he or they may institute or defend in any court of justice in this State.

Section 22. All laws or parts of laws in conflict with or inconsistent with this Act be and the same are hereby repealed.

Section 23. The fact that American foul brood now exists and is destroying honey bees in at least twenty-two counties in Texas, and that there is now no adequate statute permitting the immediate suppression and control of this and other contagious diseases of honey bees, creates an emergency and an imperative public necessity requiring the suspension of the constitutional rule which requires bills to be read on three several days, and the same is so suspended, and this Act shall take effect and be in force from and after its passage, and it is so enacted.

NOTE.—H. B. No. 11 passed the House of Representatives March 8, 1913, but no vote given; passed the Senate by a two-thirds vote, yeas 28, nays 0.

Approved March 27, 1913.

Took effect 90 days after adjournment.

# FOUL BROOD REGULATIONS.

Effective on and after March 1, 1916.

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The following regulations have been adopted by the State Entomologist in accordance with the requirements of Sections 3 and 8 of the Foul Brood Law.

These regulations are intended to facilitate the work of foul brood eradication, and while, in some few instances, their operation may cause temporary inconvenience to a few individuals, a careful study of them will, we believe, convince every beekeeper that they are no more stringent than is necessary to secure uniform action and co-operation. In fact, these regulations have been adopted primarily for the purpose of securing concerted action of the beekeepers in dealing with the foul brood scourge, in order that the disease may be successfully controlled and eradicated.

We earnestly request the full co-operation of every Texas beekeeper in securing a full compliance with these regulations, as well as with the Foul Brood Law itself.

At the end of this circular will be found the names and addresses of the inspectors assigned to duty in the counties which are quarantined. These inspectors are all practical, experienced beekeepers themselves and have the interests of the bee men thoroughly at heart. The inspectors are paid for their services by the State through the State Entomologist, and no charge is made by them for advice, inspection of bees, or for assistance rendered in the treatment of diseased colonies and apiaries. They do not, however, do work outside of the counties assigned them except upon special instructions from the State Entomologist.

### BOX HIVES.

*Regulation 1.*—Whereas, Section 3 of the Foul Brood Law of Texas empowers the State Entomologist to make regulations for eradicating and controlling diseases of bees in the State of Texas; and

Whereas, a contagious disease cannot be eradicated when the bees cannot be inspected, therefore, it is hereby ordered that on and after July 1, 1916, the honey bees in *Atascosa, Bee, Bell, Bexar, Delta, Ellis, Frio, Goliad, Hunt, Lamar, McCulloch, McLennan, Medina, Milam, San Patricio, Refugio, Uvalde, Victoria, Wilson,* and *Zavala* Counties shall be kept only in movable frame hives, permitting of ready examination. The keeping of bees in box hives, "gums," logs, barrels or other domiciles, within these counties, is unlawful. Bees kept in any form of hive except one containing movable frames permitting of ready examination, within these counties, are subject to destruction by the county

inspector at the owner's expense, as provided by Section 14 of the Foul Brood Law.

COUNTY QUARANTINES.

*Atascosa County.*

*Regulation 2.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Atascosa County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Atascosa County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Bee County.*

*Regulation 3.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Bee County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Bee County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Bell County.*

*Regulation 4.*—No bees, honey, appliances or other things capable of transmitting foul brood shall be moved or shipped into Bell County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Bell County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Bexar County.*

*Regulation 5.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Bexar County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul

brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Bexar County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Brazos County.*

*Regulation 6.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Brazos County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Brazos County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Delta County.*

*Regulation 7.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Delta County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Delta County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Ellis County.*

*Regulation 8.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Ellis County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Ellis County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Frio County.*

*Regulation 9.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Frio County, Texas, from any other county, unless accompanied by the health

certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Frio County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Goliad County.*

*Regulation 10.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Goliad County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Goliad County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Hunt County.*

*Regulation 11.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Hunt County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Hunt County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Lamar County.*

*Regulation 12.* No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Lamar County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Lamar County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*McCulloch County.*

*Regulation 13.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into McCulloch

County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of McCulloch County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*McLennan County.*

*Regulation 14.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into McLennan County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of McLennan County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Medina County.*

*Regulation 15.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Medina County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Medina County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Milam County.*

*Regulation 16.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Milam County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Milam County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Refugio County.*

*Regulation 17.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Refugio County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Refugio County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*San Patricio County.*

*Regulation 18.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into San Patricio County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of San Patricio County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Uvalde County.*

*Regulation 19.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Uvalde County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Uvalde County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Victoria County.*

*Regulation 20.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Victoria County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Victoria County whereby the bees, honey, appliances,

or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Wilson County.*

*Regulation 21.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Wilson County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Wilson County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Zavala County.*

*Regulation 22.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Zavala County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Zavala County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

Given under my hand and seal, at College Station, Texas, this 1st day of February, 1916.

(Signed) F. B. Paddock,
State Entomologist.

# FOUL BROOD REGULATIONS.

Effective on and after September 1, 1916.

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BOX HIVES.

*Regulation 24.*—It is hereby ordered that on and after September 1, 1916, the honey bees in *Comal, Falls, Fannin, Guadalupe, Hays, Leon* and *Ward* Counties shall be kept only in movable frame hives, permitting of ready examination. The keeping of bees in box hives, "gums," logs, barrels, or other domiciles, within these counties, is unlawful. Bees kept in any form of hive except one containing movable frames permitting of ready examination, within these counties, are subject to destruction by the county inspector at the owner's expense, as provided by Section 14 of the Foul Brood Law.

COUNTY QUARANTINES.

*Regulation 25.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Comal County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Comal County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 26.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Falls County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Falls County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 27.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Fannin County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Fannin County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 28.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Guadalupe County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Guadalupe County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 29.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Hays County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Hays County whereby the bees, honey, appliances or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 30.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Leon County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Leon County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 31.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Ward County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Ward County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

Given under my hand and seal, at College Station, Texas, this 1st day of May, 1916.

(Signed) F. B. Paddock,
State Entomologist.

# FOUL BROOD REGULATIONS.

Effective on and after March 1, 1917.

BOX HIVES.

*Regulation 32.*—It is hereby ordered that on and after August 31, 1917, the honey bees in *Anderson, El Paso* and *Live Oak* Counties shall be kept only in movable frame hives, permitting of ready examination. The keeping of bees in box hives, "gums," logs, barrels, or other domiciles, within these counties, is unlawful. Bees kept in any form of hive except one containing movable frames permitting of ready examination, within these counties, are subject to destruction by the county inspector at the owner's expense, as provided by Section 14 of the Foul Brood Law.

COUNTY QUARANTINES.

*Regulation 33.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Anderson County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Anderson County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 34.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into El Paso County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of El Paso County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

*Regulation 35.*—No bees, honey, appliances, or other things capable of transmitting foul brood shall be moved or shipped into Live Oak County, Texas, from any other county, unless accompanied by the health certificate of the County Apiary Inspector of the county from which the bees, honey, appliances, or other things capable of transmitting foul brood, are moved; provided, that in case there is no county inspector in the county where these originate, arrangements may be made with the inspector of Live Oak County whereby the bees, honey, appliances, or other things capable of transmitting foul brood may be inspected immediately upon their arrival at destination.

Given under my hand and seal, at College Station, Texas, this 1st day of December, 1916.

(Signed) F. B. PADDOCK,
State Entomologist.

## INFORMATION.

Parties wishing to ship bees or honey *out of quarantined counties to another* should apply for certificate to the county inspector of the county *from* which the bees or honey are to be shipped.

Parties wishing to ship bees or honey *out of quarantined counties to counties not quarantined* should apply for certificate to the county inspector of the county *from* which the bees or honey are to be shipped.

Parties desiring to ship bees or honey *into quarantined counties from counties not quarantined* should apply direct to the State Entomologist, College Station, Texas, for certificate or for permit to ship subject to inspection of the bees or honey on their arrival at destination.

Shipments of honey may be accompanied by an affidavit, secured from the State Entomologist, when inspection of bees by an inspector is not possible.

Under no circumstances will permit be given to ship, sell or move *diseased* bees or honey from such hive *anywhere* within the State of Texas.

All certificates for movement of bees and honey will be limited to thirty days following the date of inspection, but extensions of time on such certificates, in cases of emergency, may be secured on written application to the State Entomologist, approved by the county inspector.

State Entomologist.

Texas Experiment Station, College Station, Texas.

## COUNTY APIARY INSPECTORS.

For Anderson County—W. P. Bankston.....Buffalo, Texas.
For Atascosa County—G. F. Davidson.....Pleasanton, Texas.
For Bee County—E. R. Jones.....Beeville, Texas.
For Bell County—R. E. Watson.....Heidenheimer, Texas.
For Bexar County .....
For Brazos County—F. B. Paddock.....College Station, Texas.
For Comal County—John Donegan.....Seguin, Texas.
For Delta County—Jas. W. Traylor.....Enloe, Texas.
For Ellis County—T. W. Burleson.....Waxahachie, Texas.
For El Paso County—F. C. Belt.....Ysleta, Texas.
For Falls County—Geo. J. Elam.....Marlin, Texas.
For Fannin County—R. C. Abernathy.....Ladonia, Texas.
For Frio County—R. A. Little.....Pearsall, Texas.
For Goliad County—W. C. Collier.....Goliad, Texas.
For Guadalupe County—John Donegan.....Seguin, Texas.
For Hays County—John Donegan.....Seguin, Texas.
For Hunt County—W. H. White.....Greenville, Texas.
For Lamar County—E. W. Cothran.....Roxton, Texas.
For Leon County—W. P. Bankston.....Buffalo, Texas.
For Live Oak County—.....
For McCulloch County—M. C. Stearns.....Brady, Texas.
For McLennan County—N. G. LeGear.....Waco, Texas.
For Medina County .....
For Milam County—A. R. Graham.....Milano, Texas.
For Refugio County—W. C. Collier.....Goliad, Texas.
For San Patricio County—Wm. Atchley.....Mathis, Texas.
For Uvalde County—S. H. Stephens.....Uvalde, Texas.
For Victoria County—M. B. Tally.....Victoria, Texas.
For Ward County—J. W. E. Basham.....Barstow, Texas.
For Wilson County—Victor Boeer.....Jourdanton, Texas.
For Zavala County—J. B. King.....Batesville, Texas.

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 18 DECEMBER, 1916

DIVISION OF ENTOMOLOGY

# THE SAN JOSE SCALE

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS, AUSTIN, TEXAS
1916

A25-1216-7500

TEXAS AGRICULTURAL EXPERIMENT STATION

CIRCULAR NO. 18 DECEMBER, 1916

DIVISION OF ENTOMOLOGY

# THE SAN JOSE SCALE

BY

F. B. PADDOCK, M. S.,
Entomologist in Charge; State Entomologist

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

VON BOECKMANN-JONES CO., PRINTERS, AUSTIN, TEXAS
1916

# THE SAN JOSE SCALE.

BY F. B. PADDOCK, M. S., ENTOMOLOGIST IN CHARGE; STATE ENTOMOLOGIST.

## CHARACTER OF INJURY.

The San Jose scale infests practically all portions of its host plants that are above ground—the trunks, limbs, and branches—and when abundant it may occur on the leaves and fruit. Injury results from the extraction, by the scale insects, of the juices of the plant. At first this merely checks growth, but as the insects increase in number the steady killing of the branches and twigs follows, resulting finally in the death of the plants. A reddening effect is much in evidence in the form of red rings around the scales on the bark, especially of the apple and pear, and on the fruits of these plants, though not characteristic of any one scale species.

On peach trees the scales have a tendency to infest the older limbs and branches to a greater extent than the newer growth, such as the wood one year old. On apple and pear trees, the terminal twigs are quite generally infested, and many of the young scales may find their way to the fruit, settling principally on the calyx and stem cavities. Most varieties of fruit trees and plants infested from the nursery perhaps never reach fruiting condition unless treatment is given them. Peach trees will usually be killed in two or three seasons, while pear or apple trees will maintain a feeble existence much longer.

This insect, on account of its great similarity to certain other species of scale insects, may not be positively determined except by specialists. The occurrence of diseased and dying branches showing severe scale infestation furnishes strong presumptive evidence of the presence of this pest, but specimens of infested twigs should be promptly submitted to a qualified person for examination.

## DESCRIPTION OF THE INSECT.

The mature San Jose scale is small, grayish in color, circular in outline, somewhat convex, and with a nipple-like prominence in the center. The female scale is about the size of a pinhead; the male scale is much smaller and elongate. The insect proper is beneath the so-called scale, this being simply a waxy covering secreted by the soft, helpless, yellow "louse" for its own protection. Where trees and plants are only slightly infested, its presence is not readily detected by the casual observer, but in the case of severe infestation the bark of the tree and limbs will present an ashy-gray appearance, and on closer

examination will be found thoroughly incrusted with the scales, which, when scraped with a knife, will produce a yellowish, oily fluid. When the scales are abundant on the tree, the foliage also will be thoroughly infested, giving it a spotted and diseased appearance, which is readily observable at a distance of several feet.

FIGURE 1—ENLARGED VIEW OF A GROUP OF SAN JOSE SCALES.
(After Quaintance, Farmers' Bulletin 650.)

## LIFE HISTORY AND HABITS.

The San Jose scale passes the winter in an immature condition fixed to the bark of the host plant; the small, dark gray or blackish scales being just visible to the unaided eye. In early spring the growth of the scale begins, and the small, two-winged, active males issue from the male scales. After mating with the females, the males die. The females continue to grow, and in about a month begin the production of living young—minute, yellow, oval creatures—which upon very close examination may be observed without the aid of a lens, crawling here and there on the infested plants in an effort to find a suitable place for attachment. The young insect is active for some hours, but soon settles and pushes its slender, thread-like beak into the plant, and begins to feed by sucking out the sap. After this there is no movement from place to place, and the waxy covering, which often begins to develop before the insect has settled, soon covers it completely.

In about twelve days the insects molt, and from this time on the male and female scales may be readily distinguished. From eight to ten days later the males change to pupae, and in from twenty-four to twenty-six days from birth the adult male emerges. The females reach maturity and begin the production of young in from thirty-three to forty days from birth. An individual female may give birth, on the seasonal average, to about 400 young, and as the life cycle of the female covers but a few weeks, there may be several generations during a year, the number varying according to latitude. The progeny from one parent during the season have been estimated at 1,608,040,200 females.* It is thus easy to understand how the insect can so quickly destroy the plants infested, and why prompt control measures are necessary. With the approach of cool weather in fall, reproduction gradually ceases and the scales in all stages enter hibernation. Most of the older and also most of the younger individuals perish during the winter, the survivors being those about one-third or one-half grown, as stated.

## MEANS OF DISTRIBUTION.

The San Jose scale is distributed from one region to another principally on nursery stock, scions, or budding and grafting material. After the insect once becomes established in a locality its spread is accomplished by various agencies. As explained under the natural history of the insect, it is capable of movement only during a short period after birth. During this crawling stage the insects are able to pass from tree to tree where the limbs are in contact, but it is by agencies independent of itself that it is principally distributed. Prominent among these factors are birds, which may alight upon infested trees, where the young insects may crawl upon their feet and be subsequently deposited in other trees, sometimes at points quite remote. It is probable that the young are blown by strong winds from tree to tree; and they are carried by insects, such as grasshoppers, ladybird beetles, and ants. The crawling "lice" may be transported considerable distances on the clothing of man, on vehicles, or on horses, or other live stock which may be in orchards for any purpose.

## FOOD PLANTS.

The San Jose scale infests practically all deciduous fruit trees, such as apples, pears, peaches, and plums, and also many ornamental and shade trees. It is, however, seriously destructive to a much smaller number than that upon which it may actually maintain its existence.

## NATURAL ENEMIES.

This insect is subject to attack by numerous predaceous and parasitic enemies, which render important service in its control. The combined influence of these several agencies, however, is not sufficient to

*Quaintance, A. L. Farmers' Bull. 650, p. 7.

make up for the enormous reproductive capacity of this insect. To preserve the plants from destruction, its control must be accomplished by artificial means, such as the use of sprays.

## CONTROL MEASURES.

As has been stated, the San Jose scale, in the absence of proper treatment, will quickly bring about the death of many plants of economic importance. Its presence, therefore, whether in orchards or on prized fruit trees, or other plants, should call for prompt action toward its control. It has been fully demonstrated that the scale may be very successfully controlled, and its presence merely requires one thorough treatment during the dormant period of each year. On account of the general distribution of the pest, extermination measures are, in most cases, out of the question.

Complaint sometimes comes from orchardists who have the scale to contend with, that the control of the insect is neglected by their neighbors, and they believe the presence of this scale adds materially to their own work. Undoubtedly the scale will spread from orchard to orchard, but thorough annual sprayings will prevent important injury, irrespective of neglect in adjacent orchards.

Where plants are thoroughly incrusted, with consequent death of branches and stunting of growth, it is generally advisable to dig out the trees at once and replace them with new ones. Before spraying infested trees, the dead and weakened wood should be pruned out, which will simplify the work of spraying and hasten the formation of new, sound wood.

## WASHES IN USE AGAINST THE SAN JOSE SCALE.

There are several scale washes which may be employed in the control of the insect, and the one which can be most conveniently used and which is economical under the circumstances, should be selected. Thus, for spraying on a large scale, the orchardists could properly afford expenditures for the construction of cooking outfits for lime-sulfur wash, which would not be justified where only a few trees were involved. For a few plants it would be better to use some one of the prepared washes put up by manufacturers. In fact, many large orchardists prefer to use sprays of this class in preference to making the washes at home. All treatments, if possible, should be made during the dormant period (in late fall or early spring, or even during the winter in mild climates), since washes of much greater strengths may be applied at this time than when the trees are in foliage. The aim is to use a wash about as strong as the tree will stand, thereby securing the maximum killing effect upon the insects. Stone fruits, such as peaches and plums, are more susceptible to injury from sprays than apples and pears, and on the former the lime-sulfur sprays should always be used.

## LIME-SULFUR WASH.

The lime-sulfur wash has always been the standard remedy for the San Jose scale, and during the last few years has come into wide use throughout the country. This wash is a chemical combination of the lime and the sulfur. Material of the proper strength for winter use must never be used on trees that are in leaf, as it will burn the foliage. The most effective season in which to apply the winter strength of lime-sulfur is the early spring, just before the buds begin to swell. It may be applied in the fall, however, any time after the leaves drop.

There are three ways of preparing the winter wash of lime-sulfur: by diluting the commercial concentrated solution to the required strength; by making a concentrated solution at home and diluting when needed, and by making a solution which, when finished, is ready for use without diluting.

## COMMERCIAL CONCENTRATED LIME-SULFUR.

The leading manufacturers and dealers in insecticides are now selling a concentrated lime-sulfur solution which is made ready for use merely by diluting to the desired strength. This solution is sold at a price that makes the final product cost 2½ to 3 cents per gallon,—nearly as cheap as it can be made at home and with the saving of time and a disagreeable job.

Commercial concentrated lime-sulfur is a clear, reddish-brown liquid. For use, this material is simply diluted with water. The amount of water to be added is usually indicated on the container, but it is best to test the strength of the solution. This is done with a hydrometer, shown in Figure 2, which will indicate the specific gravity. These hydrometers, made especially for testing the lime-sulfur mixture, may be obtained from dealers in laboratory glassware. The dilutions should be made according to the table given later.

Since this lime-sulfur spray is quite clear, it shows but little on the trees. Some people prefer to add lime to the material after it is ready for the spray tank, but the lime should be added before the final straining. For this purpose either lump or air-slaked lime may be used, at the rate of 6 to 8 pounds to 50 gallons of the spray. There is no real advantage in adding the lime, but when used it is easier to tell when the trees have been well coated with the spray.

## HOME-MADE CONCENTRATED LIME-SULFUR.

If suitable appliances are at hand it is feasible to make up concentrated lime-sulfur at home, which can be diluted for use when needed. It is absolutely necessary to keep the finished product sealed from the air. It is also essential that the purity of the materials used are guaranteed, and it is highly important that only the best grade of lime should be used. Lime which is less than 90 per cent. pure should not be used. In most cases it will be found that the commercial concentrate is safer.

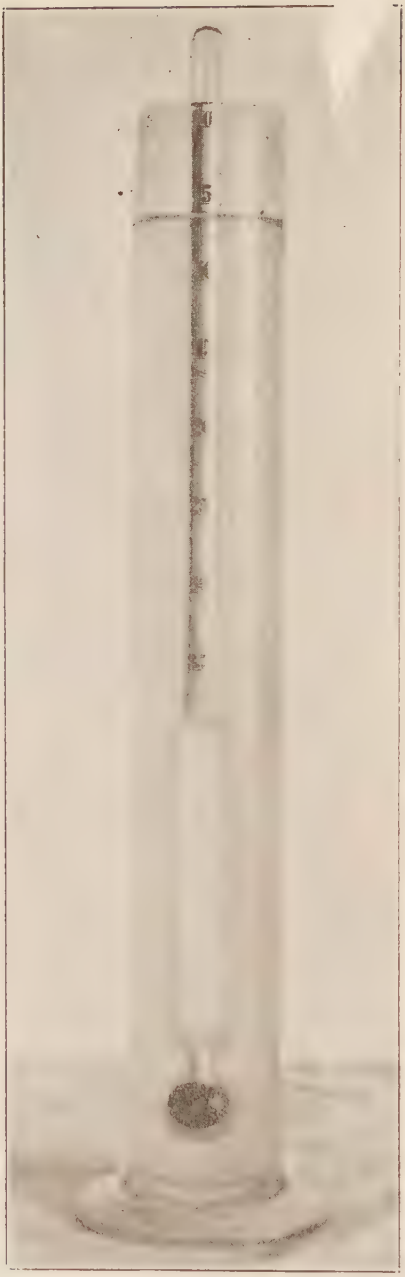

FIGURE 2.—OUTFIT FOR TESTING DENSITY OF LIME-SULFUR SOLUTION.
(Ind. Cir. 34.)

The New York [illegible] Station has made extensive experiments on the best methods of making and diluting lime-sulfur, and the following is quoted:

GENEVA STATION FORMULA FOR CONCENTRATED LIME-SULFUR.

| | |
|---|---|
| Lime, pure | 36 pounds. |
| Lime, 95 per cent. pure | 38 pounds. |
| Lime, 90 per cent. pure | 40 pounds. |
| Sulfur, high grade, finely divided | 80 pounds. |
| Water | 50 gallons. |

In making, slake the lime in about ten gallons of hot water, adding the lumps slowly so as to avoid too violent boiling. The sulfur must be well moistened and made into an even paste without lumps. Then pour the paste gradually into the slaking lime, stirring constantly to prevent the formation of lumps. When the slaking has finished add the full amount of water and boil gently for an hour. If kettles and fire are used, water must be added from time to time to make up for the loss due to the evaporation. It is much better if the cooking can be done with live steam in a closed vessel, but an open fire will do. When the boiling is done in this way the mixture will be more likely to increase the volume and it will not be necessary to add any water.

REGULAR HOME-MADE LIME-SULFUR SOLUTION.

| | |
|---|---|
| Lime (good stone) | 20 pounds. |
| Sulfur | 15 pounds. |
| Water | 50 gallons. |

This material when finished is of the proper strength for use as a winter spray without any dilution. It contains much sediment and must always be carefully strained before used.

Place the stone lime in an iron kettle and add a few gallons of hot water; then gradually add the sulfur, which has been made into a paste. Add about 12 gallons of hot water and boil hard for an hour, stirring constantly. Dilute with enough water to make 50 gallons.

FIGURE 3—SPRAYING FOR SAN JOSE SCALE WITH A BARREL SPRAYER OUTFIT (ORIGINAL).

DILUTION OF LIME-SULFUR FOR SAN JOSE SCALE.

| Reading on Hydrometer | Number of Gallons of Water to one gallon Lime-Sulfur Solution |
|---|---|
| 36 | 9 |
| 35 | $8\frac{3}{4}$ |
| 34 | $8\frac{1}{4}$ |
| 33 | 8 |
| 32 | $7\frac{1}{2}$ |
| 31 | $7\frac{1}{4}$ |
| 30 | $6\frac{3}{4}$ |
| 29 | $6\frac{1}{2}$ |
| 28 | 6 |
| 27 | $5\frac{3}{4}$ |
| 26 | $5\frac{1}{4}$ |
| 25 | 5 |
| 24 | $4\frac{1}{2}$ |
| 23 | $4\frac{1}{4}$ |
| 22 | $3\frac{3}{4}$ |
| 21 | $3\frac{1}{2}$ |
| 20 | $3\frac{1}{4}$ |
| 19 | 3 |

SPRAYING APPARATUS.

For use in the smaller orchards a barrel pump will permit of thorough work. This can be conveniently hauled about in a wagon, as shown in Figure 3. For larger orchards a hand power pump will give very satisfactory results. For commercial orchards a gasoline power spraying outfit should be employed.

A356-120-7500-L

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 19 DECEMBER, 1919

DIVISION OF SOIL SURVEY

# INVESTIGATIONS IN ADAPTING THE AUTOMOBILE TO ACCURATE SOIL SURVEY AND ROAD TRAVERSE WORK

B. YOUNGBLOOD, DIRECTOR,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

# INVESTIGATIONS IN ADAPTING THE AUTOMOBILE TO ACCURATE SOIL SURVEY AND ROAD TRAVERSE WORK

BY

*W. T. Carter, Jr., Chief, Division of Soil Survey;
†J. F. Stroud, Soil Surveyor;
T. M. Bushnell, Soil Surveyor.

In carrying on soil survey work field men have found it increasingly difficult to secure livery accommodations in all parts of the country, due to the fact that the automobile has so largely taken the place of the horse in local and short distance driving. Where the roads are such that cars may be operated in all or most parts of a county there is no doubt that it pays to use cars, even though the cost is somewhat greater, as greater distances can be covered which more than offsets the added cost.

Where a base map or good road map of a county has already been made the use of a car is a simple matter. Where a base map has to be constructed in the field and the roads accurately surveyed it is necessary to have a measuring device that will record road measurements to a small unit. Heretofore this has been satisfactorily done by the odometer, fastened to the buggy axle and there recording revolutions of the buggy wheel. The ideal size of buggy wheel is one turning exactly five hundred (500) revolutions per mile. Thus, ten revolutions of the wheel measures one space on the fiftieth-inch scale used for platting the work on the plane table.

In using the automobile for soil survey work it is of course impossible to use the ordinary speedometer for surveying roads as the smallest unit of measurement on the speedometer is one-tenth mile and there are many short tangents of roads much shorter than one-tenth mile. Because of the scarcity of men due to war conditions, and the necessity for covering large areas, it was absolutely necessary that greater efficiency be secured. Therefore the problem has been presented of getting some method of measurement that could be used in conjunction with an automobile that would be sufficiently accurate.

In the Texas soil survey, conducted cooperatively by the Texas Agricultural Experiment Station and the Bureau of Soils, United States Department of Agriculture, the first method tried was to have a two-wheeled road cart attached to the rear of a car, the odometer

*In cooperation with Bureau of Soils, U. S. Department of Agriculture.
†Resigned December 21, 1919.

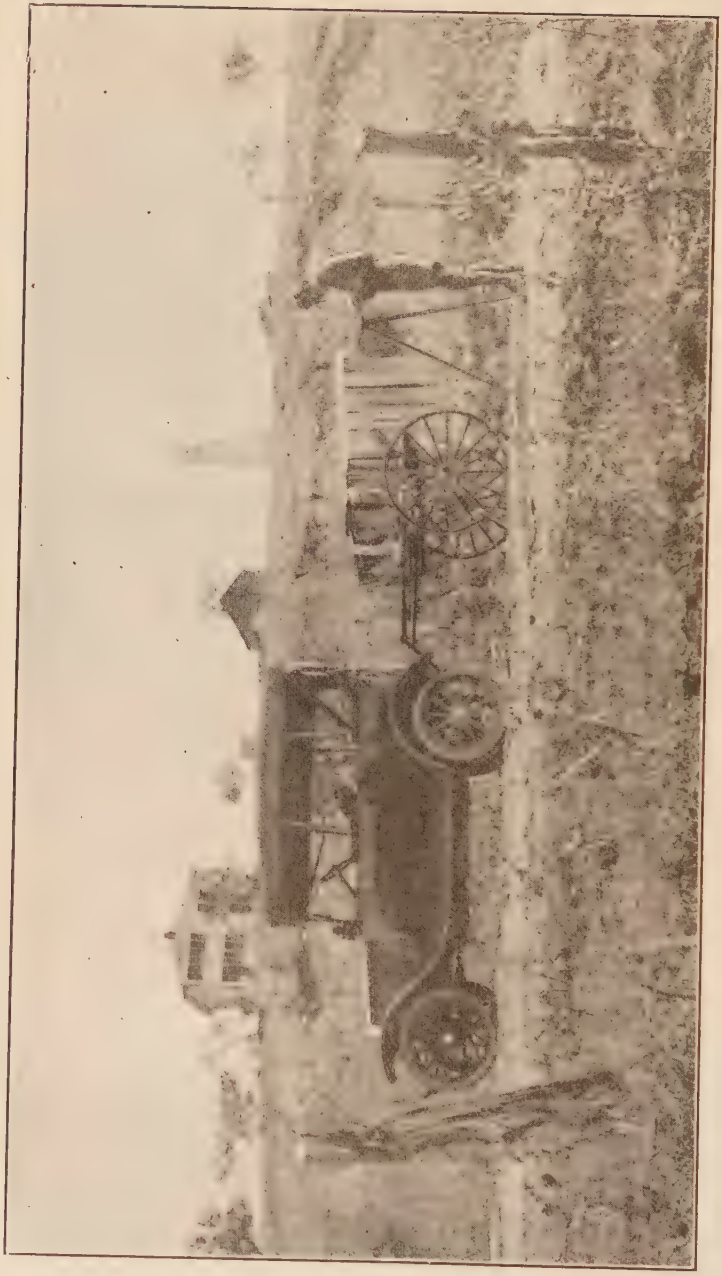

Figure 1. The cart in operation

on the road cart, and while one man operated the car the other man rode on the cart and kept a record of odometer readings. This proved a very good plan, but requires two men at all times. It is also quite a heavy load on a small car where the roads are muddy or rough and its operation consumes considerable gasoline. It is also rather rough riding for the man on the cart unless the road is absolutely smooth. The dust and the exhaust odors from the car are sometimes very uncomfortable to the men. This is a good method where the roads are good to moderately good and the results are apparently as accurate as with a buggy.

Figure 1 shows the cart in operation.

Later in the season on having to work alone for a while, Mr. J. F. Stroud, of the Texas Soil Survey, found that it was rather slow and somewhat difficult to operate the car and cart alone, as a stop had to be made at every place an odometer reading was desired. He therefore designed and had made a measuring contrivance that consists of a wheel running alongside of the car, with an attached odometer which can be read from the car seat. Figure 2 shows this contrivance in readiness for work. Figure 3 shows the attachment parts with wheel removed. This contrivance consists of the end of a buggy axle fastened to the body of the car and projecting out over the running board far enough for the wheel to work close to the car. Where fastened to the car body there is a joint or hinge that allows the axle to work up or down at the wheel-end, thus allowing the wheel to follow the inequalities of the ground without reference or influence of the car body. The axle works up and down in an iron slot fastened on the running board and a long spring is screwed down tight on top of the axle to force the wheel to stay on the ground. Figure 4 shows the wheel lifted and held from the ground by a hook when it is not desired to measure with it.

This outfit seemed to work quite well on good roads and when checked with roads surveyed with the cart it gave practically identical readings. Care must be taken to not turn too sharply with the side wheel or it will scrape along and not measure correctly. It is also probable that on very muddy or very rough roads it might not be absolutely satisfactory, but ordinarily it seems to be all right for smooth roads.

Later in the spring Mr. T. M. Bushnell, of the Texas Soil Survey, invented an appliance to attach to the ordinary automobile speedometer that has given very satisfactory results and is much more convenient than either the trailer cart or the side wheel. This is an arrangement of the regular Stewart speedometer (No. 150a) used on Ford cars. The trip mileage setter is soldered to the gears of the trip mileage

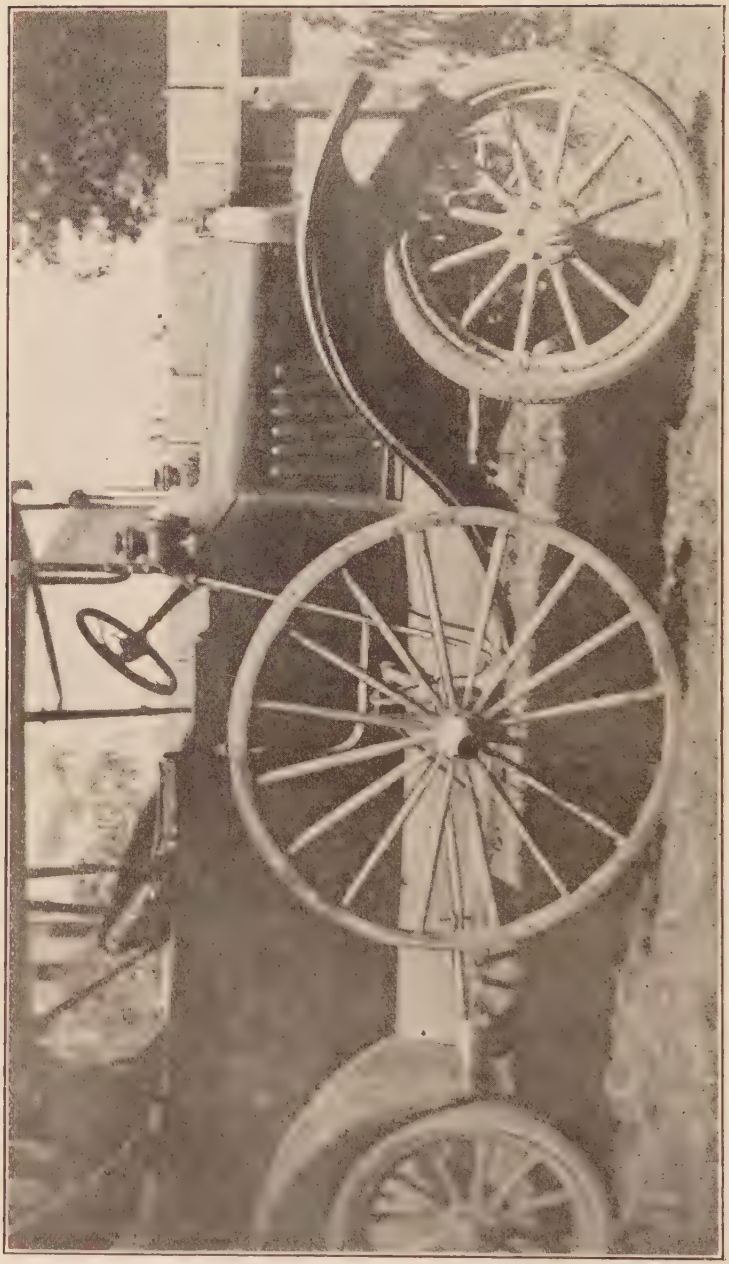

Figure 2. Special measuring contrivance designed and used in surveying Texas soils

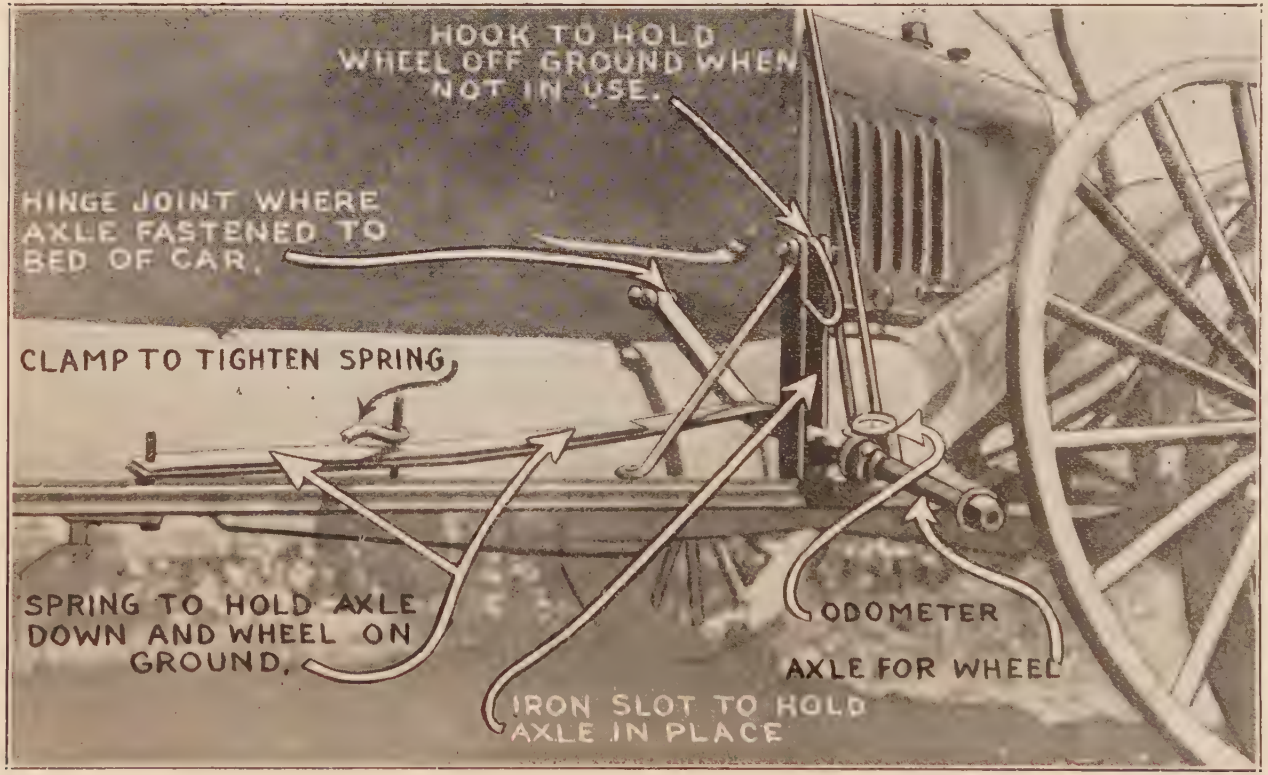
HOOK TO HOLD WHEEL OFF GROUND WHEN NOT IN USE.
HINGE JOINT WHERE AXLE FASTENED TO BED OF CAR.
CLAMP TO TIGHTEN SPRING.
SPRING TO HOLD AXLE DOWN AND WHEEL ON GROUND.
ODOMETER
AXLE FOR WHEEL
IRON SLOT TO HOLD AXLE IN PLACE

Figure 3. Attachment parts of measuring device, with wheel removed

register. This causes the mileage setter to turn completely once every mile. A large graduated dial is attached to the mileage setter and this dial then turns once in every mile. Fifty divisions are marked off on the dial and thus each division represents one space on the one-fiftieth inch on the scale used in platting the work on the plane table. Each division on the scale is subdivided into four equal parts so that readings may be read of one-two hundredth of a mile or one-fourth space on the scale division. Anyone can have this arrangement placed on the speedometer easily. The speedometer sells for $13.00 and the service station that sells the instrument will make the desired changes without extra charge. Anyone can mark off the scale and stick it on the dial. The readings of one-fourth space are close enough for all

Figure 4. Wheel lifted from ground and held by hook when not being used

practical purposes and really about as close as anyone can mark off accurately. Figure 5 shows the graduated dial attached to the trip setter. Figure 6 shows the instrument installed on the board with a jeweler's reading glass fastened over the scale to make it easy to read. A wire is stretched and fastened across the scale—just touching it so that the one-fourth scale divisions on the scale may be exactly read as the dial turns.

This instrument has been used in surveying roads and checks up with roads surveyed with the cart remarkably well. It seems to give good results in every way and there seems to be no reason why this instrument cannot be used for road traverse. The tire of the car

should be kept inflated well all the time and the slight wear of the tire does not make the wheel give results that differ to any marked extent. It seems probable that the speedometer results are even more accurate than an odometer on a buggy wheel as the car goes more nearly on a direct line and does not wobble about over the road as much as a buggy. Then in mud or sand there is not so much accumulation of dirt on the wheel or so much of the sliding effect in the loose ground with the automobile wheel as with the buggy wheel.

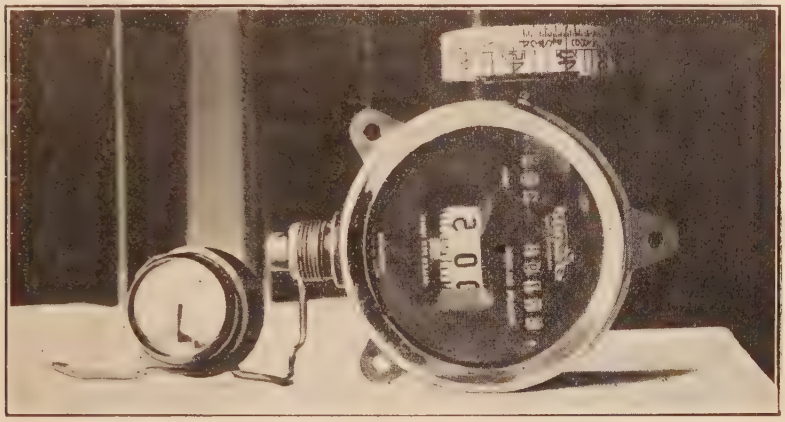

Figure 5. Graduated dial attached to trip mileage setter

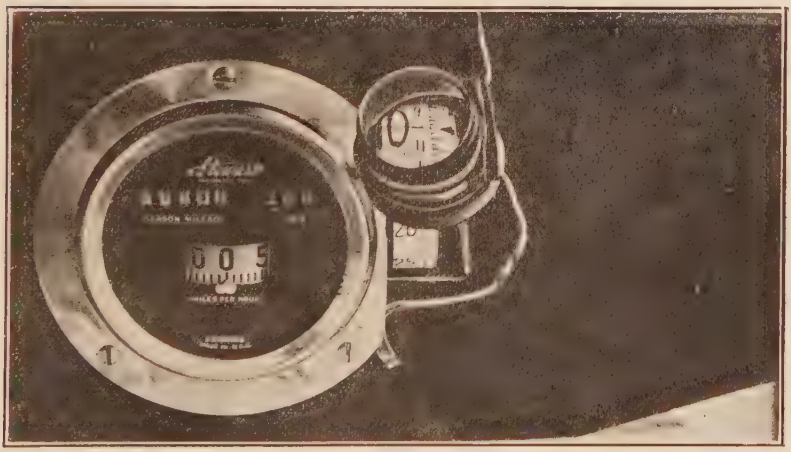

Figure 6. Dash installation of instrument, with reading glass for easy reading

The use of the speedometer for surveying roads can be safely counted on to give good results. Even if some of the base roads were run with the cart trailer or side wheel, a large part of the less important roads could then be rapidly filled in by measuring with the speedometer. Results thus far indicate, however, that a complete base map can be accurately and rapidly made with the speedometer measurements.

A420-220-15M-L

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 20 FEBRUARY, 1920

# PATCH-BUDDING LARGE LIMBS AND TRUNKS OF PECAN TREES

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CIRCULAR NO. 20. FEBRUARY, 1920.

# PATCH-BUDDING LARGE LIMBS AND TRUNKS OF PECAN TREES

BY

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It is sometimes estimated that there are 100,000,000 wild pecan trees in Texas. Certainly it would be within the mark to say there are half that number, and possibly one-half of these trees are small enough in size to make it practical from an economic standpoint to top-work them.

A pecan tree to be classed as good, must, first of all, be a heavy and regular bearer. After that, it must bear nuts of fair to large size, of thin shell, full meat, and rich flavor, and the shell must crack easily and part readily from the kernel.

From time prehistoric to the present, every such tree has been known and visited by the whole nut-eating range of the animal kingdom—from jaybird to wild turkey, from squirrel to wild hog, and from Indian to sorry white man—and very few, if any, of the nuts escaped to germinate. It was the little hard nut that got by and produced the next generation of trees.

Thus it can be seen that the general trend in the process of evolution has been one of deterioration in point of fruit.

Out of all the millions of trees in Texas there are probably not more than twenty that are really worthy of propagation by budding and grafting—that is to say, there is a very limited number of trees of surpassing excellence from which buds should be taken, and from none other.

Since it is possible by the use of these buds to transform a tree that bears a light crop of poor nuts into a tree that will bear a heavy crop of good nuts, something of the importance of this work may be comprehended.

Realizing this importance, some of the pioneers in pecan culture set about the work some twenty years ago, but with very limited success. The universal custom in the beginning was to cut the trees back severely—in fact to mere stumps—in order to force out new sprouts on which to bud. Some of these sprouts were removed, being very numerous, and the others were budded when large enough. It was very weakening to the tree to be deprived of most of its leaves during the season, but that was not the end of it. The budded sprouts must in turn be cut back in order to force new growth from the inserted buds. Thus the tree was deprived of most of its leaves the second season, and continued to suffer an insufficiency for two or three years more. In their weakened condition the trees fell easy prey to borers, and many of them

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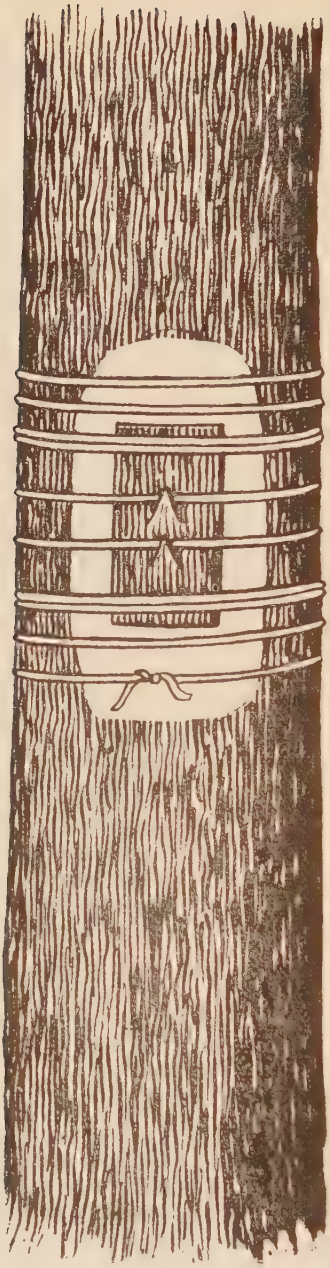

Figure 1.—The patch bud.

died during drouths. Of those that managed to live, few regained their former vigor.

The first improvement over the old system came with the introduction of the bark graft. Why not insert a graft under the bark at the ends of the stubs when the tree was cut back early in the spring? If the graft should unite and grow, the second cutting would not be necessary; and if it failed to unite, the sprouts would come just the same.

Unquestionably this was an improvement; but still the first cutting was necessary, and a high percentage of success was very difficult to obtain with the bark graft. Moreover, the nature of the union was such as to render splitting-off likely by the force of the wind against the vigorous new growth.

Having in mind the importance of the work and the weak points in the systems previously followed, the Texas Agricultural Experiment Station set about finding a means of top-working trees of considerable size without cutting them back, while at the same time securing a high percentage of successful operations.

It has been discovered that it is not necessary to have young sprouts with thin bark as stocks for budding. Buds can be successfully placed on limbs of any size, theoretically, though it is not practical to place them where the limbs are more than two inches in diameter, as the wound made by cutting back, after the bud has united, will be too long in healing over. The limiting factor in the size of limb or trunk to be budded is the wound made by cutting back, just as is the case with grafting. Any limb that is not too large to be cut back for grafting is not too large to be budded.

Figure 1 will make the operation of patch-budding in thick bark quite clear.

Before the bud from the scion is inserted, the bark of the stock should be trimmed down thin to match the bark of the bud. The pared place should be about two inches long and one and a half inches wide. One must be careful not to cut through the phloem cells in the bark of the stock while doing the paring. After the bud-patch from the scion has been placed in the matrix and tied in as shown in Figure 1, the whole pared surface, including the edges of the matrix, should be lightly waxed over to prevent drying out through evaporation. It is not necessary to wax over the bud segment as its outer bark has not been disturbed.

Following is the recipe for the wax used:

Rosin two parts and beeswax one part. Melt together and set off to cool. When it is nearly ready to resolidify, pour in wood alcohol, stirring all the while. Continue till the mass is bright yellow in color and quite soft. The quantity of alcohol necessary is about two-thirds the volume of the other combined materials. Grain alcohol is best; wood alcohol will do, but *denatured alcohol will not do.*

The binding strings should be cut about three weeks after the buds were put on. The strings are likely to cut into the bark and interfere with the circulation if left for a longer period. In fact, it is thought that many buds are killed by the strings in this way. Experiments with rubber bands instead of strings showed a higher percentage of living buds. If the rubber bands are used they need not be cut at all, as they will decay from the action of the wax and will break before the three-weeks period is out.

Figure 2.—Pecan tree after budding.

The buds will have formed a good union by the end of three weeks if they are ever going to do so and the budded branches should then be cut off at a point a foot beyond the buds in order to force them out. Some branches just above the buds should also be cut off close to the body of the tree so as to let in the light and air and to leave room for the new growth from the buds.

Figure 2 is a photographic reproduction of a tree worked by this method on the grounds of the Experiment Station at College Station, Texas, April 7, 1919. The tree is six inches in diameter a foot above the ground, and the four budded limbs range from an inch to two inches in diameter near the body of the tree. Each of the four branches grew toward one of the cardinal points of the compass, and their arrangement, one above another, obviates the formation of a crotch. Not so much as a single leaf of this tree was cut at the time of budding, and had the buds not lived the tree would have been neither mutilated nor weakened. Examination three weeks after budding, however, showed the buds to have united, and the branches were then cut as above suggested, and all branches above the budded ones were removed for a distance of three feet.

The growth from the buds is now (November 26, 1919) from two to three feet in length, and is in vigorous condition. The top of the tree will be cut out just above the topmost budded limb before the sap rises in the spring, and the forced growth of the budded portion will soon provide leaves enough to perform the full functions of a top.

A tree three inches in diameter that had grown in a forest and had no low branches for budding had a new head formed in this way. The buds were placed on the trunk of the tree five or six feet above ground, and were forced out, not by cutting off the top of the tree, but by wounds just above the topmost inserted bud. Each wound was a slight saw-cut directly above the bud to be forced. The combined effect of the wounds was not sufficient to entirely obstruct the passage of elaborated plant foods, but each wound did obstruct the pathway of passage to its particular bud, and thus forced it out.

The top of this tree will be removed before spring.

All remarks about forcing buds apply, in point of time, to only those operations performed before midsummer. Buds put on after that time should be left dormant till the following spring, when the same methods of forcing should be applied.

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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 21 APRIL, 1920

# THE RESEARCH SPIRIT IN SCIENTIFIC INSTITUTIONS

B. YOUNGBLOOD, DIRECTOR,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

Circular No. 21. April, 1920.

# THE RESEARCH SPIRIT IN SCIENTIFIC INSTITUTIONS

BY

B. Youngblood, Director.

The research spirit is a sort of healthful contagion which animates the real investigator and pervades all truly scientific institutions. It is an enthusiasm for original inquiry, enlivened and made effective by individual genius. It is realized that not every man possessing an inquisitive turn of mind is a successful investigator; yet, ability would lie dormant were it not enshrined in a scientific spirit.

The scientist is happiest and has the best chances for a successful career who is imaginative enough to conceive a friendly spirit ever attending him and guiding him in his work. This may be called the Spirit of Research. It is the spirit which leads students to ask questions and make inquiries for themselves and which moves teachers to lead their students into unexplored fields of knowledge wherein prospecting is often well rewarded. It is the spirit which enables one to perceive problems of importance, to attack them with vigor and enthusiasm, and to interpret results with discretion. It is the spirit which prompts one to frankly ask for guidance when the trail becomes dim and moves his fellows to render aid and encouragement when one is in need of it. A spirit of research, moreover, is one of philanthropic impulse. It causes one to devote himself more seriously to the problems pertaining to the well-being and happiness of mankind than to the satisfaction of his own requirements.

The pioneers in scientific research lived largely to themselves, out of touch with the world, and were little known except by their discoveries or inventions, and, even then, often, not until many years after their time. The modern idea of "playing to the galleries" was unknown to them. They serve, in many respects, as an example worthy of emulation. Their story appeals strongly to the popular imagination because of their unusual and unselfish devotion to their chosen lines of inquiry. They worked in improvised and inexpensive laboratories with inadequacy of equipment. Many of them made their studies practically without funds either for their work or for their own subsistence. As a rule, they spent their lives on but a single problem.

Modern scientists have vastly increased the number of discoveries and inventions, as one should have expected on considering their superior training, equipment, and environment. It might prove helpful to the cause, however, if attention were called to some of the criticisms made by certain persons having the general welfare at heart. The following are some of the more common criticisms—the merits of which need not be discussed just here.

1. Many research men are considered lazy. Inasmuch as it is impossible for the layman to know just when the scientist is doing his best work or is idle, how can he judge the scientist who often does best work by merely thinking soundly, shut up in his room by himself?

It behooves the scientist, however, so to conduct himself as to make it obvious that he is a busy man. If the public sees one living example of a lazy scientist, it is likely to conclude that all scientists are lazy. This is unfair to the scientist, but it is a human defect, which can only be remedied in a human way.

2. There is also a popular notion that scientists are "cranky." There is little doubt but that some scientists are "cranky," but it would be difficult to establish the fact that scientists are any more "cranky" than men of other professions. The fact is that the world has an ample number of pigeon-holes in which it automatically places its cranks of every kind. The scientific crank may be found under the "S's." He pays the penalty of being a crank along with all the rest of his kind. Most scientific men, however, are not cranks. On the other hand, they are highly essential to the element of accuracy in the statement of natural truths. It may be said of most scientific men that, instead of being cranks, they are *tediously* CORRECT. The man who is correct is quite commonly called a crank by the man who wants anything but the facts in a case in which he is concerned. Still, it may be said of some perfectly sound scientists that they are correct to an alarming extent—to the extent, sometimes, of making enemies when they might as easily make friends. Some scientists have been known to be insultingly correct. Would it not be better for the cause, if these men, instead, would be pleasant in all their precision?

3. Another popular criticism of scientists is that they are too individualistic and self-centered. In their defense, it may be said, however, that the individualistic genius, the mutating type of man, is the fountain-head and source of the greater part of all that has been accomplished in discovery and invention throughout history. On the other hand, it is considered that scientific men, the mutants, can be of greatest service to the world, if they will display a broad spirit of liberality towards their contemporaries in the scientific field.

The modern spirit of research answers every criticism. It is the intelligent, energetic, friendly spirit of scientific men joining hands, when to do so is mutually advantageous, in the accomplishment of certain results. It seems that the war did more to bring scientists together, to get them to consulting one another, and displaying the "I-trust-you" type of spirit, than anything that has ever occurred. Within the institution, it is the hope of the administration that problems affecting our agriculture will be taken up from the viewpoint of various specialists. This means that there must be cooperation in the work of the several specialists. It does not mean, however, that there will be any decline in the need for individual initiative. It means that the abilities of the several specialists may be coordinated into a general, well-rounded-out line of projects which will prove more valuable, with the results more quickly available than could otherwise possibly be the case.

It is sincerely hoped that in the A. and M. College of Texas, the true scientific spirit will be nourished and disseminated to the extent that the research of this institution may attract students from everywhere and that it may be admired and respected for its scientific attainments by every good citizen of the State and nation.

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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

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# THE MALVACEOUS PLANTS OF TEXAS

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## FOREWORD.

This circular is based on a survey of the Malvaceous plants in Texas, made by the author under the auspices of the Federal Horticultural Board and is published with the approval of the Secretary of Agriculture. The presence of many wild and cultivated plants related to cotton and their possible use as host plants of the pink boll worm warrants the publication of this report, showing the number of species and their distribution.

A. B. CONNER,
Acting Director.

April 30, 1920.

# KEY TO THE MALVACEOUS PLANTS IN TEXAS[1]

HERBERT C. HANSON.*

## INTRODUCTION.

Plants of the family *Malvaceae* in Texas are very important on account of the economic uses of many of its species, and on account of their occurrence as weeds and as possible host plants to pests of cotton and other economic malvaceous plants. The most important economic plant of this family is, of course, cotton. The young pods of okra, *Hibiscus esculentus*, are widely used as a food. There are numerous species that are grown ornamentally in gardens, yards, and parks. These are: *Hibiscus manihot*, *H. trionum* (Flower-of-an-Hour), *H. sabdariffa* (Roselle), *H. syriacus* (Shrubby Althaea), *H. rosa-sinensis* (Chinese Hibiscus), *H. cardiophyllus*, *H. coccineus*, *H. militaris* (Sweating Weed), *H. lasiocarpus*, *Althaea rosea* (Hollyhock), *Malva sylvestris* (Garden Mallow), *Malvaviscus arboreus*, and *Malvaviscus drummondii*. A few species, now growing wild in the state, as *Kosteletzkya althaeifolia*, *Pavonia lasiopetala*, and *Abutilon pedunculare*, would very likely make splendid decorative plants. Clumps of *Kostelezkya* are very attractive on account of the large masses of pink flowers. *Pavonia* and *Abutilon* have very attractive flowers. The calyx of roselle, *Hibiscus sabdariffa*, is used for making jelly and preserves. The plant is not entirely hardy in the vicinity of Houston and Galveston, but the Lower Rio Grande Valley appears very favorable for it. Several species of *Abutilon*, the larger *Sphaeralceas*, and *Sida rhombifolia* could possibly be used for the production of fiber. Several species of *Sida* and *Sphaeralcea* form very nutritive and palatable forage if utilized before the plants become too fibrous. Many species are common weeds. The most common are: *Sida rhombifolia* in southeastern Texas, *Disella hederacea* and the larger *Sphaeralceas* in irrigated soil in western Texas, and species of *Sida* and *Malva* throughout the state.

The family *Malvaceae* is easily recognized. One of the best ways to recognize the family is to observe the structure of the column of stamens around the pistil. This is formed by the union of the filaments. The one-celled anthers are borne on the summit of this column or along the upper part. The number of carpels that compose the pistil varies from about five to many. The calyx is made up of five more or less united sepals and the hypogynous corolla of five more or less united petals. In some cultivated forms, as in Shrubby Althaea, the corolla is double. The leaves are alternate, palmately veined, and entire, or lobed, or variously divided. The species are herbs, shrubs, and, rarely, small trees.

[1]The work upon which this paper is based was done under the auspices of the Federal Horticultural Board. The specific purpose of the work was to determine whether the presence of malvaceous plants, other than cotton, was important in non-cotton zones established for the purpose of eradicating the pink boll worm. In all the inspections of the malvaceous plants, other than cotton, the pink boll worm was not found.

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In the following key 87 species in 22 genera of the family, Malvaceae, are recorded.

KEY TO THE GENERA.

A. Fruit a few-celled, many-seeded capsule which splits when ripe; stamen column anther-bearing for a considerable part of its length.

B. Styles united; seeds not kidney-shaped.

C. Bractlets of the involucel toothed or incised, conspicuous 1. *Gossypium.*

C. Bractlets of the involucel entire, not conspicuous 2. *Cienfuegosia.*

B. Styles not united, spreading; seeds kidney-shaped.

C. Fruit as long or longer than broad; more than one seed in each carpel 3. *Hibiscus.*

C. Fruit not as long as broad; one seed in each carpel 4. *Kostelezkya.*

A. Fruit composed of carpels that are closely united into a ring around the axis from which they separate when ripe; stamen column anther-bearing mostly at summit.

B. Carpels as many as the stigmas.

C. Carpels 2—to several—seeded.

D. Carpels one-celled.

E. Calyx without bracts.

F. Carpels leathery, not bladdery, usually pointed at apex 5. *Abutilon.*

F. Carpels membranous, bladder-like, rounded at apex 6. *Gayoides.*

E. Calyx with bracts 7. *Sphaeralcea.*

D. Carpels two-celled, sometimes divided imperfectly into two parts by protuberances of the ovary wall.

E. Involucel wanting; stems upright 8. *Wissadula.*

E. Involucel of 3 bractlets; stems usually prostrate 9 *Modiola.*

C. Carpels one-seeded.

D. Carpels splitting when ripe; stigmas capitate.

E. Calyx bracted.

F. Flowers white; stems prostrate 10. *Disella.*

F. Flowers orange to pink; stems erect 11. *Malvastrum.*

E. Calyx not bracted.

F. Perennials; carpels erect, tips connivent or erect.

G. Stems very hairy, sticky; fruit a 5-valved capsule 12. *Bastardia.*

G. Stems smooth or hairy, not sticky; fruit of 5 to many carpels 13. *Sida.*

F. Annuals; carpels depressed, tips spreading.

G Flowers axillary; carpels 8-20 14. *Anoda.*

G. Flowers in racemes or panicles; carpels usually 5 15. *Sidanoda.*

D. Carpels not splitting when ripe; stigmas not capitate.

E. Involucel of 6-9 bractlets 16. *Althaea.*

E. Involucel of 0-3 bractlets.

F. Carpels beaked; bractlets 0-3; petals as if gnawed at apex 17. *Callirrhoe.*

F. Carpels not beaked; bractlets 3; petals notched at apex 18. *Malva.*

B. Carpels one-half as many as the stigmas.

C. Carpels dry.

D. Flowers and fruit in a head; flowers inconspicuous; petals yellow 20. *Malachra.*

D. Flowers and fruit not in a head; flowers showy; petals pink 21. *Pavonia.*

C. Carpels fleshy, red, berry-like 22. *Malvaviscus.*

1. *Gossypium.* Cotton.

A. Seeds glabrous, completely separable from the lint, 4-5 mm. broad 1. *G. Barbadense.*

A. Seeds not glabrous, 6-7 mm. broad 2. *G. herbaceum.*

1. *Gossypium Barbadense* L. Sea-island cotton. Rarely grown as a decorative plant in southern Texas.

2. *Gossypium herbaceum* L. Common cotton. Cultivated throughout most of Texas. Frequently found volunteer in old fields and waste places.

2. *Cienfuegosia.*

1. *Cienfuegosia sulphurea* (St. Hil.) Garcke. Common in rich, moist, black soil only in the vicinity of Corpus Christi, Taft, Gregory.

3. *Hibiscus.* Rose Mallow.

A. Fruit 4 to 21 cm. long; calyx spathe-like.

B. Fruit 4-8 cm. long; bractlets oblong or oblong-lanceolate . 1. *H. Manihot.*

B. Fruit 9-21 cm. long; bractlets linear 2. *H. esculentus.*

A. Fruit less than 4 cm. long; calyx not spathe-like.

B. Calyx inflated and bladder-like 3. *H. Trionum.*

B. Calyx fitting closely to pod.

C. Plant cultivated for edible calyx, from which preserves are made 4. *H. sabdariffa.*

C. Plant not cultivated for edible calyx.

D. Tall, cultivated shrubs or small trees; flowers single or double.

E. Leaf more or less deeply 3-lobed, coarsely crenate 5. *H. syriacus.*

E. Leaf not lobed, coarsely dentate 6. *H. Rosa-sinensis.*

D. Herbs or low shrubs.

E. Sepals united only at base, spreading.

F. Petals deep rose-purple; leaves broadly heart-shaped 7. *H. cardiophyllus.*

F. Petals sulphur-yellow; leaves usually 3-lobed or divided 8. *H. coulteri.*

F. Petals light purple; leaves broadly ovate 9. *H. denudatus. var. involucellatus.*

E. Sepals partially united into a campanulate tube.

F. Leaf-blade divided into 3-7 segments; cultivated only 10. *H. coccineus.*

F. Leaf-blade toothed or lobed; wild or cultivated.

G. Leaves glabrous or nearly so; calyx accrescent, lobes shorter than the tube 11. *H. militaris.*

G. Leaves densely pubescent; calyx not accrescent, lobes longer than tube 12. *H. lasiocarpus.*

1. *Hibiscus Manihot* L. Rarely grown as a decorative plant.

2. *Hibiscus esculentus* L. Okra. Cultivated for young green pods throughout Texas.

3. *Hibiscus Trionum* L. Flower-of-an-Hour. Occasionally grown in gardens, rarely a weed near gardens.

4. *Hibiscus sabdariffa.* L. Roselle. Rarely cultivated in southern Texas for edible calyx.

5. *H. syriacus* L. Shrubby Althaea, Rose of Sharon. Common as a decorative plant throughout Texas. Many forms with single or double flowers occur.

6. *Hibiscus Rosa-sinensis* L. Chinese Hibiscus. Common as a decorative plant throughout southern Texas. Varieties from low shrubs to small trees with single or double flowers.

7. *Hibiscus cardiophyllus* Gray. Dry or rocky soil, Brownsville to Del Rio. Occasionally cultivated for showy red flower in Lower Rio Grande Valley. Brownsville, Harlingen, Laredo, Mission, Uvalde, Eagle Pass, Del Rio, Rio Grande City.

8. *Hibiscus coulteri* Gray. Rocky soil from Del Rio west to New Mexico. Del Rio, Sanderson, Boquillas, Presidio, Candelaria, El Paso.

9. *Hibiscus denudatus* var. *involucellatus* Gray. Rocky soil west of the Pecos. Marathon, Boquillas, Redford, Candelaria, El Paso.

10. *Hibiscus coccineus* Walt. Rarely grown as a decorative plant in southern Texas.

11. *Hibiscus militaris* Cav. Sweating Weed. Moist soil, southeastern Texas. Chambers, Jefferson and Orange counties. Rarely cultivated as a decorative plant.

12. *Hibiscus lasiocarpus* Cav. Common in wet and swampy soil in southeastern Texas. Chambers, Jefferson, Orange, Liberty, and Harris counties.

### 4. *Kostelezkya.*

1. *Kostelezkya althaeifolia* (Chapm.) Gray. Swamps near bays, southeastern Texas. Orange, Jefferson, Chambers, and Galveston (eastern part) counties. Rarely cultivated as a decorative plant.

### 5. *Abutilon.*

A. Carpels 11-30.

B. Perennial; peduncles longer than the petioles.

C. Petals salmon-colored; carpel beaks spreading 1. *A. pedunculare.*

C. Petals yellow; carpel beaks erect 2. *A. jacquini.*

B. Annual; peduncles much shorter than the petioles 3. *A. Abutilon.*

A. Carpels 5-10.

B. Carpels 10 mm. or more high.

C. Stems erect, 1-2 meters tall; carpels short-beaked 4. *A. berlandieri.*

C. Stems usually decumbent, less than ½ meter long; carpels long-beaked 5. *A. wrightii.*

B. Carpels less than 10 mm. high.

C. Stems 3-angled. 6. *A. triquetrum.*

C. Stems not 3-angled.

D. Stems slender, spreading or decumbent; carpels usually short-beaked 7. *A. parvulum.*

D. Stems stout and erect; carpels usually rounded at apex.

E. Sepals more than 5 mm. long; carpels 5 8. *A. malacum.*

E. Sepals less than 5 mm. long; carpels 8-9.

F. Petals red or pink; carpels 4-7 mm. high 9. *A. texense.*

F. Petals yellow; carpels 8-9 mm. high 10. *A. incanum.*

1. *Abutilon pedunculare* H. B. K. In palm woods near Brownsville, but very rare.

2. *Abutilon jacquini Don.* In palm woods near Brownsville, but rare.

3. *Abutilon abutilon* (L.) Rusby. Reported by Small as occurring in waste places in Texas. Not found in southern or western Texas.

4. *Abutilon berlandieri* Gray. Open woods and large chaparral, southwestern Texas. Corpus Christi, San Antonio, Brownsville, Mission, Rio Grande City, Laredo, Cotulla.

5. *Abutilon wrightii* Gray. Rocky soil, southwestern Texas. Corpus Christi, San Antonio, Laredo, Eagle Pass, Balmorhea, Davis Mts., Big Bend.

6. *Abutilon triquetrum* (L.) Presl. Woods near Brownsville.

7. *Abutilon parvulum* Gray. Dry soil, southwestern Texas.

8. *Abutilon malacum* S. Wats. Rocky slopes, western Texas, Balmorhea, Davis Mts., Boquillas, Redford, Ruidosa, Candelaria, El Paso.

9. *Abutilon texense* T. & G. Plains, western Texas. Reported for southern Texas. Barstow, Ozona.

10. *Abutilon incanum* (Link.) Sweet. Woods, rocky slopes, southwestern and western Texas. Austin, Kerrville, San Antonio, Brownsville, Ladera, Eagle Pass, Del Rio, Ozona, Fort Stockton.

## 6. *Gayoides.*

1. *Gayoides crispum* (Grisch.) Small. Woods, rocky slopes, southern and western Texas. Laredo, Davis Mts., Big Bend.

## 7. *Sphaeralcea.*

A. Leaves digitately 5-parted.

B. Flowers in dense clusters; petals 5-8 mm. long.

C. Plants about 6 dcm. high; carpels always one-seeded 1. *S. pedata.*

C. Plants 1-2.5 dcm. high; carpels 1-2 seeded 2. *S. pedatifida.*

B. Flowers solitary, not dense; petals 12-15 mm. long 3. *S. tenuipes.*

A. Leaves 3-parted or simple.

B. Fruit depressed-globose; carpels falling away completely from axis.

C. Flowers 15-20 mm. long 4. *S. hastulata.*

C. Flowers 10-12 mm. long.

D. Leaves pinnatifid; terminal portion conspicuously lobed; pedicels long and slender 5. *S. pumila.*

D. Leaves not pinnatifid, cordate, ovate or oblong-lanceolate, rarely subhastately 3-lobed.

E. Leaves ovate to oblong, mostly subhastate; petals purplish 6. *S. subhastata.*

E. Leaves mostly cordate, not subhastate; petals rose-red to white.

F. Pubescence closely stellate; leaves crenulate-toothed; petals white to rose 7. *S. ambigua.*

F. Pubescence loose, wooly; leaves more rounded, crenate; petals rose-red 8. *S. lindheimeri.*

B. Fruit little or not at all depressed; carpels after separating from axis cohering with each other by their sides and held by a short thread.

C. Leaves narrowly oblong, or lanceolate and subhastate; plants tall and stout.

D. Leaves narrowly oblong, not lobed 9. *S. cuspidata.*

D. Leaves lanceolate, subhastate with 2 rounded lobes at base, broader than the preceding 10. *S. lobata.*

C. Leaves round-ovate in outline, lobed; plants lower and more slender.

D. Pubescence fine and very dense; lobes of leaf round-ovate 11. *S. incana.*

D. Pubescence coarse and loose; lobes of leaf toothed 12. *S. fendleri.*

1. *Sphaeralcea pedata* Torr. Reported by Coulter for western Texas.

2. *Sphaeralcea pedatifida* Gray. Dry soil, southwestern Texas. Hebronville, Laredo, Cotulla, Eagle Pass.

3. *Sphaeralcea tenuipes* Woot. & Stand. Rocky slopes, extreme western Texas. Sierra Blanco, El Paso.

4. *Sphaeralcea hastulata* Gray. Prairies and plains, southwestern Texas. Roma, Hebronville, Laredo, Uvalde, Del Rio.

5. *Sphaeralcea pumila* Woot. & Stand. Sandy soil, extreme western Texas. El Paso.

6. *Sphaeralcea subhastata* Coult. Sandy clay soil, western Texas. Pecos, Sierra Blanca, Shafter.

7. *Sphaeralcea ambigua* Gray. Reported by Coulter from Duval county.

8. *Sphaeralcea lindheimeri* Gray. Reported by Coulter from the Guadalupe River southward.

9. *Sphaeralcea cuspidata* (Gray) Britton. Slopes and valleys, weed in cultivated soil, western Texas. Eagle Pass, Cotulla, Del Rio, Marfa, Big Bend, Pecos, El Paso.

10. *Sphaeralcea lobata Woot.* Nigger Weed, Yerba del Negro. Valleys and lower slopes, weed in and near fields, western Texas. Pecos, Barstow, Ruidosa, Alpine, El Paso.

11. *Sphaeralcea incana* Torr. Dry, rocky and sandy slopes, western Texas. Davis Mts., Alpine, El Paso.

12. *Sphaeralcea fendleri Gray.* Reported by Coulter in mountains of extreme western Texas.

### 8. *Wissadula.*

A. Petals less than 5 mm. long — 1. *W. periplocifolia.*

A. Petals more than 10 mm. long.

B. Calyx usually about the same length or shorter than fruit, short-pointed; in clay or loam soil usually — 2. *W. lozani*

B. Calyx usually longer than fruit, long-pointed; leaves more lanceolate than the preceding; in rocky soil. — 3. *W. holosericea.*

1. *Wissadula periplocifolia* (L.) Griseb. Open woods, wood edges, vicinity of Brownsville.

2. *Wissadula lozani* (Rose) Fries. Mesquite woods, southwestern Texas. Corpus Christi, Brownsville, Mission, Laredo, San Antonio, Uvalde.

3. *Wissadula holosericea* (Scheele) Garcke. Rocky soil, western Texas. Alpine, Davis Mts., Balmorhea.

### 9. *Modiola.*

1. *Modiola caroliniana* (L.) G. Don. Low, moist, waste places, southern Texas. Hearne, Beaumont, Anahuac, Liberty, Houston, San Antonio, Brownsville.

10. *Disella.*

A. Plants loosely stellate-pubescent; leaves rounded at apex
1. *D. hederacea.*

A. Plants densely pubescent with scurfy scale-like hairs; leaves acute at apex.

B. Leaves usually obliquely ovate, rarely lobed at base
2. *D. lepidota.*

B. Leaves narrowly oblong, with conspicuous narrow lobes at base
3. *D. sagittaefolia.*

1. *Disella hederacea* (Dougl.) Greene. Meloncilla. Valleys near streams, soil usually alkaline, western Texas. Indio, El Paso.

2. *Disella lepidota* (Gray) Greene. Open valleys and plains, western Texas. Marathon, Boquillas, Redford, Indio.

3. *Disella sagittaefolia* (Gray) Greene. Dry Plains, western Texas. Alpine.

11. *Malvastrum.*

A. Petals yellow.

B. Flowers in dense terminal spikes 1. *M. spicatum.*

B. Flowers axillary.

C. Carpels 15-20; pubescence of very short scale-like hairs
2. *M. wrightii.*

C. Carpels 8-12; pubescence strigose 3. *M. americanum.*

A. Petals red or crimson.

B. Plants covered with peltate scales; leaf divisions linear
4. *M. leptophyllum.*

B. Plants covered with loose stellate hairs; leaf divisions oblong to linear.

C. Plants 30-40 cm. high, slender; terminal lobe of leaves much longer than the others 5. *M. elatum.*

C. Plants 10-20 cm. high, stout; terminal segments of leaves only slightly longer than the others 6. *M. coccineum.*

1. *Malvastrum spicatum* (L.) Gray. Open woods, weed in fields and along roads, Lower Rio Grande Valley. Brownsville, Harlingen, Mission.

2. *Malvastrum wrightii* Gray. Open mesquite. Corpus Christi.

3. *Malvastrum americanum* (L.) Torr. Open woods, weed in fields and waste places, southern and southwestern Texas. Beaumont, Anahuac, Houston, Corpus Christi, San Antonio, Brownsville, Mission, Laredo, Eagle Pass, Del Rio.

4. *Malvastrum leptophyllum* Gray. Dry soil, western Texas.

5. *Malvastrum elatum* (Baker) Nels. Open valleys and lower slopes, western Texas. Davis Mts., Alpine, Sierra Blanca, El Paso.

6. *Malvastrum coccineum* (Pursh.) Gray. Open plains and hills, western Texas. Alpine.

## 12. *Bastardia.*

1. *Bastardia viscosa* (L.) H. B. K. In mesquite and prickly pear vegetation near Brownsville.

## 13. *Sida.*

A. Calyx accompanied by 1-3 bractlets.
  B. Carpels acuminate; petals yellow — 1. *S. cuneifolia.*
  B. Carpels obtuse; petals copper-colored — 2. *S. helleri.*

A. Calyx not accompanied by bractlets.
  B. Calyx enlarging around or under the fruit — 3. *S. physocalyx*
  B. Calyx not enlarging around or under the fruit.
    C. Stems or branches decumbent or prostrate.
      D. Flowers in leafy involucres at ends of branches — 4. *S. ciliaris.*
      D. Flowers not in leafy involucres at ends of branches.
        E. Stems or branches hoary, minutely pubescent; calyx lobes acute — 5. *S. filiformis.*
        E. Stems or branches with spreading hairs; calyx lobes acuminate — 6. *S. diffusa.*
    C. Stems and branches erect or ascending.
      D. Corolla violet-purple; calyx not angled — 7. *S. filipes.*
      D. Corolla not violet-purple; calyx 5-angled.
        E. Leaf blades ovate to cuneate or lanceolate.
          F. Carpels 5; entire leaf blade serrate — 8. *S. spinosa.*
          F. Carpels about 8; entire leaf blade serrate — 9. *S. tragiaefolia.*
          F. Carpels 10-12; leaf blades serrate except at base — 10. *S. rhombifolia.*
        E. Leaf blades linear or linear oblong.
          F. Peduncles and usually both peduncle and pedicel, shorter than the leaves to which they are attached.
            G. Calyx less than 6 mm. high at maturity — 11. *S. angustifolia.*
            G. Calyx more than 6 mm. high at maturity.
              H. Plant 1-3 dcm. high; petals orange-yellow, often changing to red — 12. *S. neomexicana.*
              H. Plant 3-9 dcm. high; petals yellow — 13. *S. texana.*
          F. Peduncles conspicuously elongated, much surpassing the leaves to which they are attached — 14. *S. Longipes.*

1. *Sida cuneifolia* Gray. Sandy, sometimes alkaline soil, southwestern Texas. Brownsville, Hebronville, Laredo.

2. *Sida helleri* Rose. Reported by Small as occurring in sandy soil near Corpus Christi.

3. *Sida physocalyx* Gray. Woods, plains, and prairies, southwestern and western Texas. San Antonio, Kerrville, Brownsville, Laredo, Eagle Pass, Del Rio, Ozona, Pecos, Marfa, Big Bend, El Paso.

4. *Sida ciliaris* L. Weed in fields and along roads, southern Texas. Gregory, Corpus Christi, Riviera.

5. *Sida filiformis* Moric. Dry soil over most of Texas. Dallas, San Antonio, Brownsville, Laredo, Pecos, Big Bend, El Paso.

6. *Sida diffusa* H. B. K. Dry soil over most of Texas. Hearne, San Antonio, Brownsville, Laredo, Pecos, Big Bend, El Paso.

7. *Sida filipes* Gray. Reported by Small for dry soil, Texas. Reported by Coulter for hills between the Colorado and Pecos rivers.

8. *Sida spinosa* L. Woods and weed in fields, southern Texas. Beaumont, Anahuac, Houston, Gregory, Brownsville.

9. *Sida tragiaefolia* L. Dry soil, western Texas. Boquillas, Alpine.

10. *Sida rhombifolia* L. Weed, southeastern Texas. Jefferson, Hardin, Chambers, Harris, Galveston counties.

11. *Sida angustifolia* Lam. Dry soil and weed, southwestern Texas. Brownsville, Laredo, Cotulla.

12. *Sida neomexicana* Gray. Rocky mountain slopes, western Texas. Davis Mts.

13. *Sida texana* (T. & G.) Small. Reported by Small for dry soil, Texas. Reported by Coulter as occurring in southern and eastern Texas.

14. *Sida longipes* Gray. Rocky slopes, western Texas. Sanderson, Marathon. Reported by Coulter from Duval county.

### 14. *Anoda.*

A. Petals lavender; sepals much longer than the fruit
1. *A. lavaterioides.*

A. Petals yellow; sepals about the same length as the fruit
2. *A. wrightii*

1. *Anoda lavaterioides* Medic. Reported by Wooton and Standley as occurring in western Texas.

2. *Anoda wrightii* Gray. Reported by Coulter as occurring in western Texas.

### 15. *Sidanoda.*

1. *Sidanoda pentachista* (Gray) Woot. & Stand. Reported by Wooton and Standley as occurring in western Texas. Reported by Coulter for southwestern Texas.

### 16. *Altheae.* Hollyhock.

1. *Althaea rosea* L. Common as a decorative plant throughout Texas.

17. *Callirrhoe.* Poppy Mallow.

A. Plants annual.
  B. Involucel present; carpels densely pubescent 1. *C. scabriuscula.*
  B. Involucel not present; carpels glabrous 2. *C. pedata.*
A. Plants perennial or biennial.
  B. Involucels present.
    C. Several flowers on a peduncle 3. *C. triangulata.*
    C. One flower on a peduncle.
      D. Calyx and involucel bractlets separated 4. *C. papaver.*
      D. Calyx and involucel bractlets contiguous.
        E. Lobes of leaf crenate 5. *C. geranioides.*
        E. Segments of leaf incised or pinnately parted.
          F. Corolla purple or red 6. *C. involucrata.*
          F. Corolla pink or lilac 7. *C. lineariloba.*
  B. Involucels wanting.
    C. Petals pink or rose. 1-1½ cm. long. 8. *C. alcaeoides.*
    C. Petals red-purple, violet or white, 1½-2 cm. long 9. *C. digitata.*

1. *Callirrhoe scabriuscula* Robinson. Reported by Small as occurring along the Colorado River.

2. *Callirrhoe pedata* Gray. Reported by Small and Coulter as occurring on prairies in Texas.

3. *Callirrhoe triangulata* (Leavenw.) Gray. Reported by Small as occurring on prairies in Texas.

4. *Callirrhoe papaver* (Cass.) Gray. Reported by Small as occurring on sandy soil in Texas.

5. *Callirrhoe geranioides* Small. Reported by Small as occurring on sandy soil in bottoms in southern Texas.

6. *Callirrhoe involucrata* (Nutt.) Gray. Prairies and plains throughout most of Texas. Galveston county, Hearne, San Antonio, Laredo, Del Rio, Ozona, Pecos, Sheffield.

7. *Callirrhoe lineariloba* (T. & G.) Gray. Sandy soil, southern Texas. Hebronville.

8. *Callirrhoe alcaeoides* (Michx.) Gray. Reported by Small as occurring in dry soil in Texas. Reported by Coulter as occurring in gravel soil in Gillespie county.

9. *Callirrhoe digitata* Nutt. Prairies and valleys, most of Texas. San Antonio, Corpus Christi, Del Rio, Ozona, Pecos, Sheffield.

18. *Malva.* Mallow.

A. Corolla over 2 cm. broad 1. *M. sylvestris.*

A. Corolla less than 2 cm. broad.

B. Petals 3½-7 mm. long; plants erect 2. *M. parviflora.*

B. Petals 9-14 mm. long; plants decumbent 3. *M. rotundifolia.*

Garden Mallow.

1. *Malva sylvestris* L. Cultivated throughout most of Texas.

2. *Malva parviflora* L. Common weed, southern and western Texas. Corpus Christi, San Antonio, Brownsville, Laredo, Kerrville, Del Rio, El Paso.

3. *Malva rotundifolia* L. Weed in waste ground. Brazos county.

19. *Sidalcea.*

1. *Sidalcea neomexicana* Gray. Reported by Coulter as occurring in mountains of western Texas.

20. *Malachra.*

1. *Malachra capitata* L. Woods, weed in fields, vicinity of Brownsville.

21. *Pavonia.*

1. *Pavonia lasiopetala* Scheele. Dry, rocky ravine near New Braunfels. Reported by Coulter as occurring throughout southern and western Texas. Reported by Small as occurring in dry and rocky woods in Texas.

22. *Malvaviscus.*

A. Flowers more than 5 cm. long; cultivated only 1. *M. arboreus.*

A. Flowers less than 2.5 cm. long; wild and cultivated 2. *M. drummondii.*

1. *Malvaviscus arboreus* Cav. Cultivated as a decorative shrub in Brownsville.

2. *Malvaviscus drummondii* T. & G. Woods and thickets, southern and eastern Texas. Frequently cultivated. Beaumont, Hearne, Houston, Austin, San Antonio, Corpus Christi, Brownsville, Laredo.

GLOSSARY.

*Anther.* The part of the stamen which contains the pollen.

*Bract.* A leaf-like structure subtending the flower, or flower-cluster.

*Bractlet.* A secondary bract, immediately beneath the flower; sometimes applied to very small bracts.

*Capitate.* Shaped like a head; parts collected into a dense cluster.

*Capsule.* A dry fruit consisting of more than one carpel, splitting open when ripe.

*Carpel.* A part of a compound pistil.

*Crenate.* Margin of a leaf with rounded teeth.

*Dentate.* Margin of leaf with pointed teeth.

*Digitate.* Parts diverging, like the fingers when spread.

*Involucre.* A whorl of bracts subtending the flower.

*Involucel.* A secondary involucre.

*Panicle.* A compound inflorescence, of the racemose type, as oats.

*Pedicel.* The stalk of a single flower in a flower cluster.

*Peduncle.* A primary flower stalk, supporting either a single flower or a cluster of flowers. If a flower stalk is jointed, the part nearest the stem is the peduncle, and the part nearest the flower is the pedicel.

*Peltate.* Shield-shaped.

*Petiole.* The stalk of the leaf.

*Pinnate.* Compound, with the parts arranged on each side of a common axis.

*Raceme.* An elongated inflorescence with the flowers attached to the main stem by a single branch.

*Spathe.* A bract that is concave.

*Spike.* An inflorescence where the flowers are sessile, or nearly so, on a more or less elongated common axis.

*Stamen.* The pollen-bearing organ of the flower, composed of anther and filament.

*Stamen-column.* The united portion of several stamens.

*Stellate.* Star-shaped.

*Stigma.* The part of the pistil that receives the pollen.

*Strigose.* With appressed stiff hairs.

*Style.* Usually the stem-like part of the pistil between the ovary and the stigma.

*Subhastate.* Shaped somewhat like an arrow-head.

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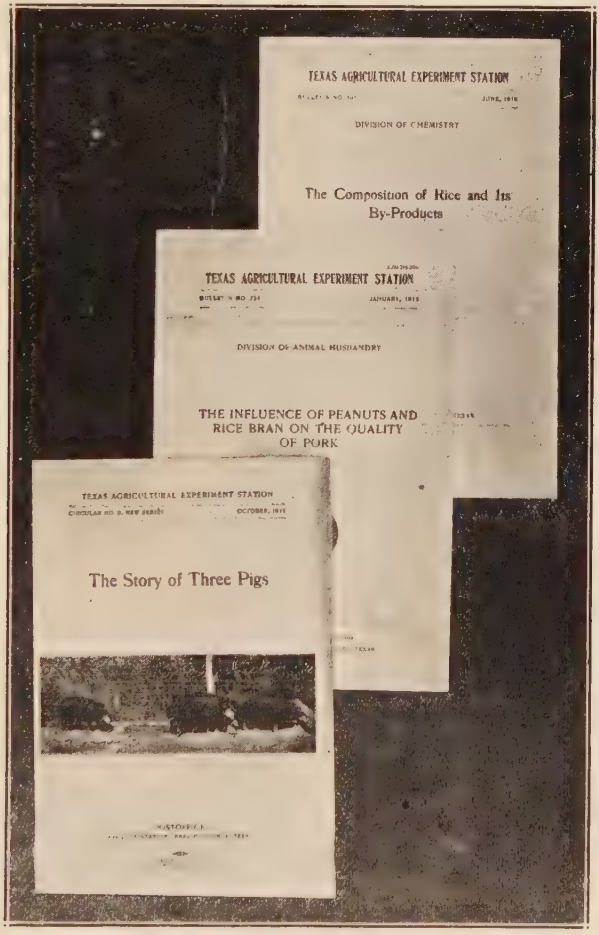
# TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 23 AUGUST, 1920

## RELIABLE AGRICULTURAL INFORMATION AND HOW TO SECURE IT


TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF CHEMISTRY
The Composition of Rice and Its By-Products
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ANIMAL HUSBANDRY
THE INFLUENCE OF PEANUTS AND RICE BRAN ON THE QUALITY OF PORK
TEXAS AGRICULTURAL EXPERIMENT STATION
The Story of Three Pigs

B. YOUNGBLOOD, DIRECTOR,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

## FOREWORD

This circular concerning reliable agricultural information is issued for the purpose of calling attention to the available bulletins issued by the Texas Agricultural Experiment Station for free distribution to the citizens of this State. The Texas Agricultural Experiment Station is an agency supported by the State of Texas for the investigation of agricultural problems. These problems are studied by means of carefully conducted experiments made by thoroughly practical men with expert knowledge of scientific agriculture. The information contained in the bulletins offered is wholly reliable. Only a part of it may be applicable to a particular farm, and therefore the citizen must be the judge of the extent to which he can use the information in his particular business. It is hoped that this circular will be the means of bringing into more general use the bulletins issued by this station.

A. B. Conner,
Vice-Director.

# RELIABLE AGRICULTURAL INFORMATION AND HOW TO SECURE IT

A. B. Conner.

The bulletins available for distribution at this time relate to the subjects of live stock, live stock diseases, crops, crop diseases, insects injurious to plant and animal life, soils and means of making soils more productive, plant breeding, horticulture, the composition and utilization of feeds, forestry, and farm and ranch management. One hundred sixteen publications are available at this time, any of which may be had by request to the Director of the Experiment Station. A complete list of available publications follows:

The following is a list of the Texas Agricultural Experiment Station publications available for free distribution. Anything shown on this list will be sent free upon application to "The Director, Texas Agricultural Experiment Station, College Station, Texas." Please request publications by number. Write plainly.

Publications *not* shown on this list *cannot* be supplied.

BULLETINS.

No.

113. Spray Calendar.
119. Infectious Anaemia of the Horse.
124. The Pecan Case Bearer.
126. Active Phosphoric Acid in Its Relation to the Needs of the Soil for Phosphoric Acid in Pot Experiments.
128. Cottonseed Meal as Human Food.
129. Studies of the Ammonia Soluble Organic Matter of the Soil.
132. Report of the Cooperative Forage Crop Work by the United States Department of Agriculture and the Texas State Experiment Station at Chillicothe, Texas, in 1909.
137. Alfalfa in Northwest Texas.
144. The Culture of Cigar Leaf Tobacco in Texas.
148. Report of Experiments with Citrus Fruits at the Beeville Substation.
155. The Ether Extract and the Chloroform Extract of Soils.
158. Investigations Pertaining to Texas Beekeeping.
159. Steer Feeding.
162. Composition and Digestibility of the Chloroform Extract of Texas Hays and Fodders.
163. Digestion Experiments on Men with Cottonseed Meal.
165. Ammonia-Soluble Inorganic Soil Colloids.
166. Digestion Experiments with Texas Feeding Stuffs.

THE VALUE OF AGRICULTURAL INFORMATION DEPENDS ON ITS USE.

No:
167. Commercial Fertilizers and Their Use.
169. The Total Fatty Acids and Other Ether-Soluble Constituents of Feedstuffs.
170. Texas Feeding Stuffs: Their Composition and Utilization.
171. Losses of Moisture and Plant Food by Percolation.
172. Sudan Grass.
173. The Composition of the Soils of the Texas Panhandle.
174. The Effect of Organic Compounds in Pot Experiments.
175. Distribution and Digestibility of the Pentosans of Feeds.
178. Effect of the Additions on Availability of Soil Phosphates.
180. The Turnip Louse.
181. Oxidation of Organic Compounds in the Soil.
182. Steer Feeding.
183. Moisture Relations of Some Texas Soils.
184. Cooperative Fertilizer Experiments with Corn, 1908-14.
185. The Production Co-efficients of Feeds.
186. Fattening Lambs.
187. Sprays and Spraying.
188. Tile Drainage.
189. The Composition of Cottonseed Meal and Cottonseed.
190. The Effect of Additions on the Availability of Soil Potash, and the Preparation of Sugar Humus.
191. The Composition of Rice and Its By-Products.
192. Soils of Grayson, Lee, McLennan, Titus, and Tyler Counties.
195. Japanese Sugar Cane as a Forage Crop.
196. Digestibility of Sugars, Starches, and Pentosans of Roughages.
197. Progress Report, Substation No. 3, Angleton, Texas, 1909-14.
198. Feeding Baby Beeves.
199. Progress Report, Substation No. 6, Denton, Texas, 1909-14.
200. Progress Report, Substation No. 4, Beaumont, Texas, 1909-14.
201. Peanut Meal and Ground Whole Pressed Peanuts for Hogs.
202. Progress Report, Substation No. 12, Chillicothe, Texas, 1905-14.
203. The Productive Values of Some Texas Feeding Stuffs.
204. The Recurving of Milo and Some Factors Influencing It.
205. Sheep Breeding and Feeding.
206. Poultry Feed and Feeding Results.
207. Poultry Houses and Poultry Equipment for Texas.
208. The Fig in Texas.
209. Progress Report, Substation No. 2, Troup, Texas, 1909-14.
210. Barns for Work Animals.
211. Field Experiments with Crown Gall, 1913-17.
212. The Availability of Phosphoric Acid in Rock Phosphate.
213. The Composition of the Soils of South Central Texas.
214. Progress Report, Substation No. 1, Beeville, Texas, 1910-14.
215. Progress Report, Substation No. 5, Temple, Texas, 1910-14.
216. Commercial Feeding Stuffs, 1916-17.

THE VALUE OF AGRICULTURAL INFORMATION DEPENDS ON ITS USE.

No.
217. Commercial Fertilizers in 1916-17.
218. Progress Report, Substation No. 7, Spur, Texas, 1909-14.
219. Progress Report, Substation No. 8, Lubbock, Texas, 1909-14.
220. Egg-Producing Values of Some Texas Feeding Stuffs.
221. Progress Report, Substation No. 9, Pecos, Texas, 1910-14.
222. The Composition of Peanuts and Peanut By-Products.
223. Effect of Lime and Carbonate of Lime on Acid Phosphate.
224. The Influence of Peanuts and Rice Bran on the Quality of Pork.
225. Cocoanut Meal vs. Cottonseed Meal for Dairy Cows.
226. Cooperative Soft Pork Investigations.
227. Studies of the Harlequin Bug.
228. Influence of Peanut Meal on Quality of Pork.
229. Experiments at Substation No. 3, Angleton, Texas, 1909-16.
230. Spacing of Rows in Corn and Its Effect on Grain Yield.
231. The Beemoth or Waxworm.
232. Mineral Requirements of Sheep.
233. Commercial Fertilizers in 1917-18.
234. Commercial Feeding Stuffs in 1917-18.
235. Cooperative Fertilizer Experiments with Cotton, Corn, Sweet Potatoes and Irish Potatoes, 1908-17.
236. Grain Sorghum Improvement.
238. Dairy Cattle Feeding Experiments.
239. Control of Weeds in Rice Fields.
240. The Utilization of Yucca for the Maintenance of Cattle.
241. Cottonseed Meal.
242. Hardening Peanut-Fed Hogs.
243. The Need of Texas Soils for Lime.
244. Composition of the Soils of Archer, Franklin, and Harrison Counties.
245. Feeding Values of Certain Feeding Stuffs.
246. Report of the First Texas National Egg-Laying Contest.
247. The Chemical Composition of the Cotton Plant.
248. Commercial Fertilizers in 1918-19.
249. Field Diseases of the Sweet Potato in Texas.
250. Storage and Diseases of the Sweet Potato in Texas.
251. Commercial Feeding Stuffs, September 1, 1918, to August 31, 1919.
252. Commercial Feeding Stuffs Registered for Sale in Texas, October 1, 1919.
253. Report of Experiments at Substation No. 12, Chillicothe, Texas, 1915-17.
254. Report of Experiments at Substation No. 11, Nacogdoches, Texas, 1916-18.
255. Beekeeping for Beginners.
256. The Cowpea Weevil.
257. The Cotton Melon Louse; Life History Studies.

No.
258. Report of Experiments at Substation No. 4, Beaumont, Texas, 1915-18.
259. Nitrification in Texas Soils.
260. Wilts of the Watermelon and Related Crops.
261. Diseases of Grains, Sorghums, and Millet, and Their Control in Texas.
262. The Searing Iron vs. The Knife for Docking or Detailing Lambs.
264. Farm Records and Accounts.
265. Commercial Fertilizers in 1919-20.
266. The Staple of Texas Cotton.

ANNUAL REPORTS.

25th.
26th.
27th.
28th.
29th.
30th—31st.
32d.

PRESS BULLETIN.

Broom Corn Culture.

CIRCULARS.

(New Series.)

No.
1. Strawberries Under Irrigation in South Texas.
3. Truck Farming in Texas.
7. Insect Enemies of Sudan Grass.
9. The Story of Three Pigs.
10. Housing Farm Implements (Superseding Circular No. 4).
12. Progress in Peanut Milling.
13. The Green Bug or Spring Grain Aphis.
15. A Milk House for Texas.
16. Directions for Preparation of Veterinary Specimens for Examination.
18. The San Jose Scale.
19. Investigations in Adapting the Automobile to Accurate Soil Survey and Road Traverse Work.
20. Patch-Budding Large Limbs and Trunks of Pecan Trees.
21. The Research Spirit in Scientific Institutions.
22. The Malvaceous Plants of Texas.
23. Reliable Agricultural Information and How to Secure It.

Not more than one copy of a particular publication will be sent to a given individual or agency. Those wishing publications sent to

certain parties will kindly send a list of such names and addresses, and indicate the publications to be sent each.

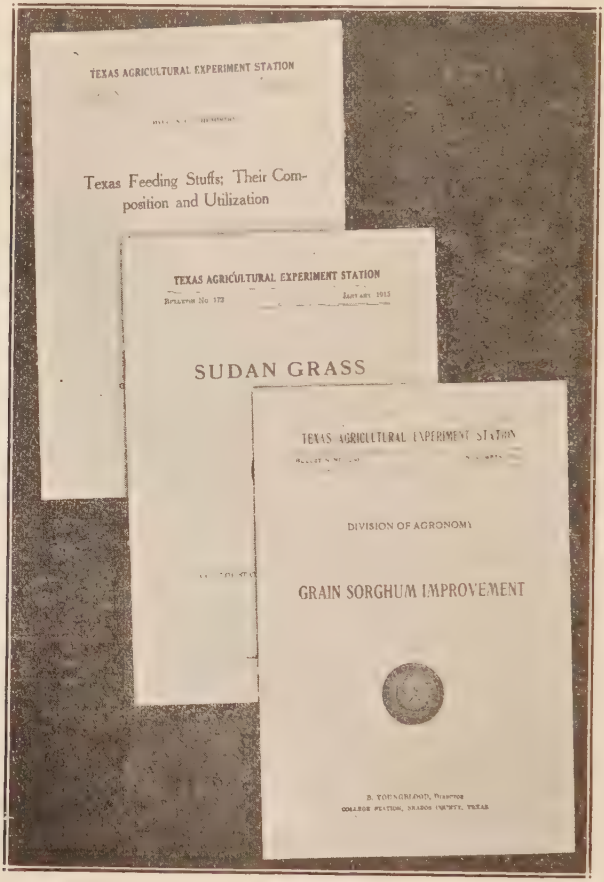
Parties asking for publications which are out of print will receive a copy of this list, together with such literature as may be available, bearing on the same subject as the publications which are out of print.

Please request publications by NUMBER.

Address all communications to:

B. YOUNGBLOOD,
Director, Texas Agricultural Experiment Station,
College Station, Texas.

**All Reliable Agencies Engaged in the Dissemination of Agricultural Information Must Base Their Teachings on the Principles Evolved by Research Studies, as Otherwise Their Teachings Might be Unsound.**

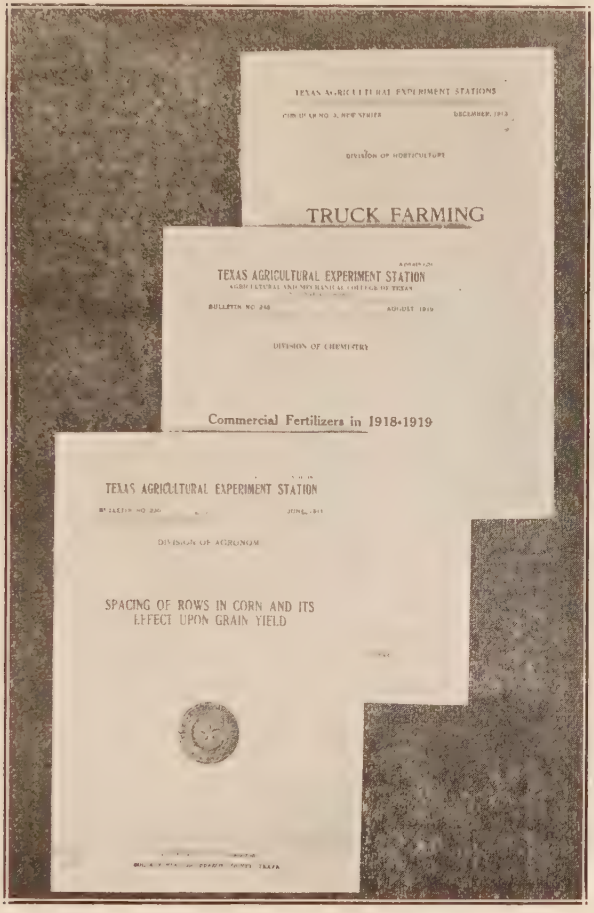



**Texas Feeding Stuffs: Their Composition and Utilization:** This bulletin gives complete information as to the composition and utilization of some feedstuffs commonly grown in this State. You can utilize the feed you grow most profitably by knowing its feeding value.

**Sudan Grass:** This bulletin gives a complete history of Sudan Grass, its introduction, distribution and culture. It is invaluable to anyone growing this crop.

**Grain Sorghum Improvement:** This bulletin gives reliable information as to how to proceed in increasing the grain and forage yield of the grain sorghum so commonly grown throughout Western Texas. This applies to milo, kafir, feterita, and the various other grain sorghum varieties.

THE VALUE OF AGRICULTURAL INFORMATION DEPENDS ON ITS USE.

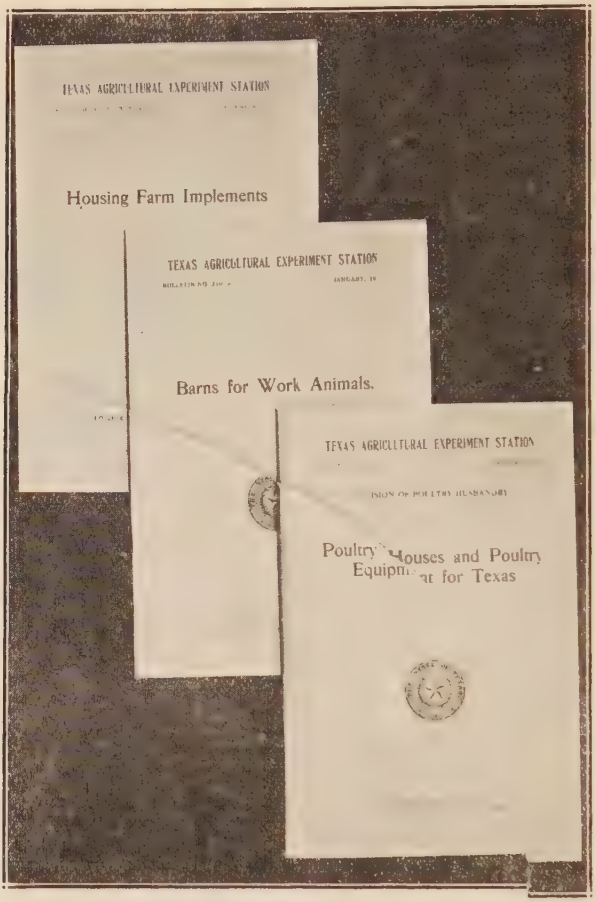

TRUCK FARMING
TEXAS AGRICULTURAL EXPERIMENT STATION
Commercial Fertilizers in 1918-1919
TEXAS AGRICULTURAL EXPERIMENT STATION
SPACING OF ROWS IN CORN AND ITS EFFECT UPON GRAIN YIELD

**Truck Farming:** A complete manual for the guidance of the truck farmer; discusses preparation of the soil for truck crops and gives specific information as to planting, cultivating and harvesting in the most profitable manner.

**Commercial Fertilizers:** A discussion of commercial fertilizers, their composition and use in increasing production.

**Spacing of Rows in Corn and Its Effect Upon Grain Yield:** This bulletin gives the results of six years of careful experimentation at six different points in the State and shows conclusively the effects upon grain yield of growing corn in wide and narrow rows.

THE VALUE OF AGRICULTURAL INFORMATION DEPENDS ON ITS USE.


TEXAS AGRICULTURAL EXPERIMENT STATION
Housing Farm Implements
TEXAS AGRICULTURAL EXPERIMENT STATION
Barns for Work Animals.
TEXAS AGRICULTURAL EXPERIMENT STATION
Poultry Houses and Poultry Equipment for Texas

**Housing Farm Implements:** This circular contains sketches showing the construction of farm implement sheds and the bill of materials required. Many thousands of dollars worth of farm implements are being ruined in Texas because of lack of housing. Suitable implement sheds are inexpensive and as a protection to farm machinery pay big returns.

**Barns for Work Animals:** Contains plans and bill of materials for barns suitable to Texas conditions. It pays to house farm live stock and it is economical to study various plans before building.

**Poultry Houses and Poultry Equipment for Texas.** A bulletin containing plans for poultry houses and poultry equipment suitable to Texas conditions. The farm poultry pays returns as perhaps no other part of the farm. Provide a house and sanitary conditions and thus encourage even greater production.

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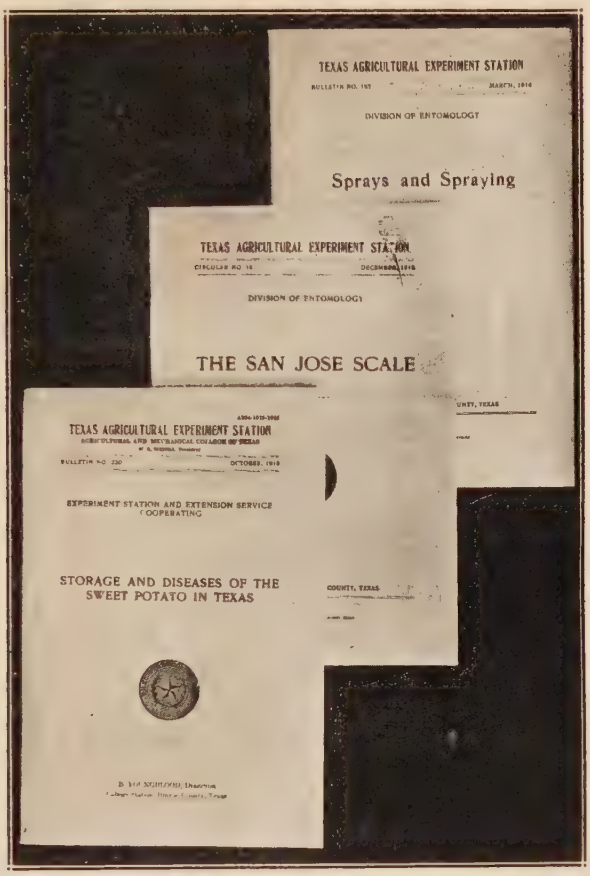
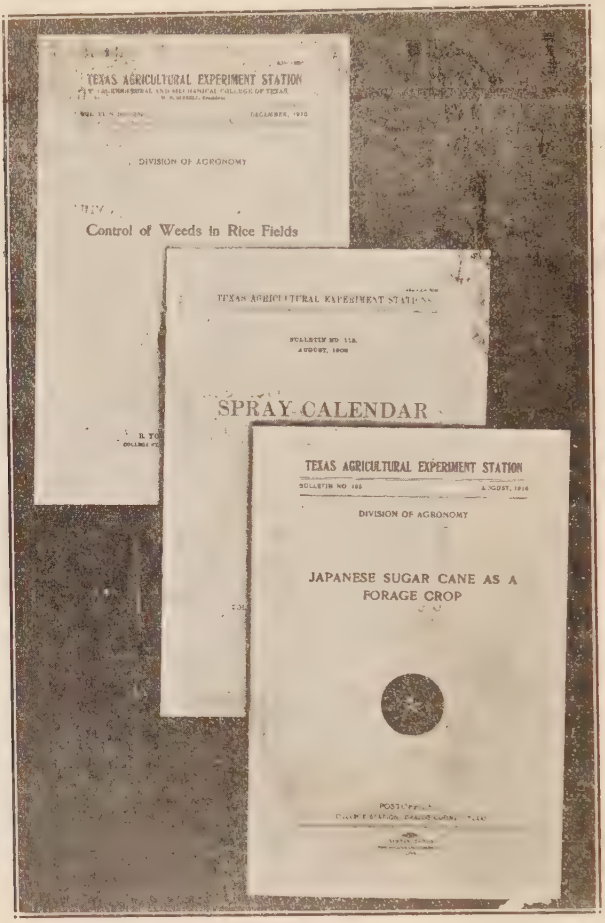

TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ENTOMOLOGY
Sprays and Spraying
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ENTOMOLOGY
THE SAN JOSE SCALE
TEXAS AGRICULTURAL EXPERIMENT STATION
EXPERIMENT STATION AND EXTENSION SERVICE
COOPERATING
STORAGE AND DISEASES OF THE SWEET POTATO IN TEXAS

**Sprays and Spraying:** A bulletin giving various formulas for making up sprays and information as to how and when to apply for the control of insects.

**The San Jose Scale:** A complete description of the San Jose scale, its distribution and means of control. Write for this bulletin and familiarize yourself with the San Jose scale and thus protect against the loss of trees.

**Storage and Diseases of the Sweet Potato in Texas:** A complete bulletin on the storage and storage diseases of the sweet potato. There are many ways of avoiding storage losses which it will save you money to know.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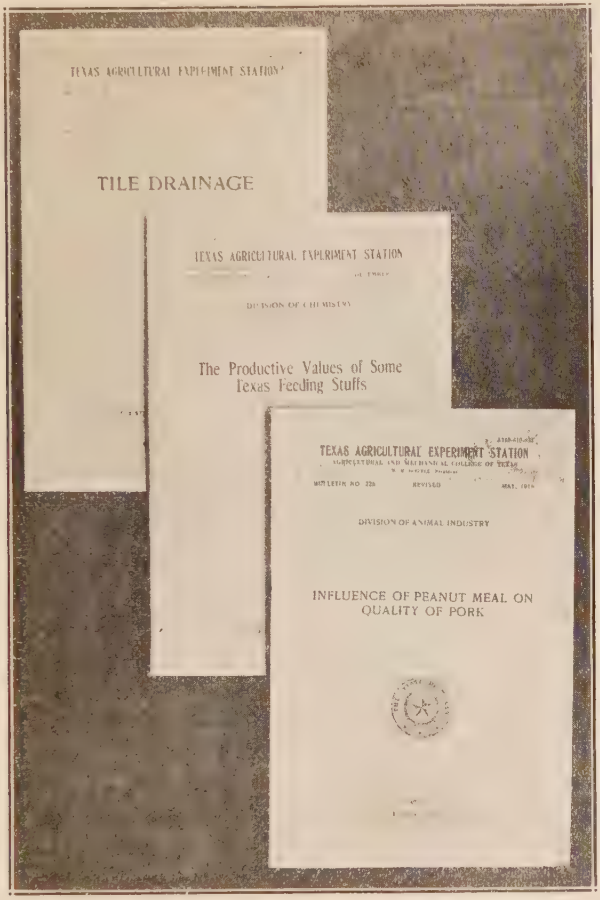
DIVISION OF AGRONOMY
Control of Weeds in Rice Fields
TEXAS AGRICULTURAL EXPERIMENT STATION
SPRAY CALENDAR
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF AGRONOMY
JAPANESE SUGAR CANE AS A FORAGE CROP

**Control of Weeds in Rice Fields:** This bulletin discusses in detail rice field weeds, their means of distribution and how to control them based on carefully conducted experiments at the Texas Agricultural Experiment Rice Station located near Beaumont. Weeds in rice fields annually cause losses of thousands of dollars which can in a large measure be avoided.

**Spray Calendar:** This bulletin contains formulae for making up sprays and suggestions as to the best time for spraying to get best results.

**Japanese Sugar Cane as a Forage Crop:** Japanese sugar cane is a most excellent forage crop in the gulf coastal plains section and in that region has many advantages over other forages. This bulletin gives information as to planting, cultivating, harvesting and storing; also yield that may be expected from the crop from year to year.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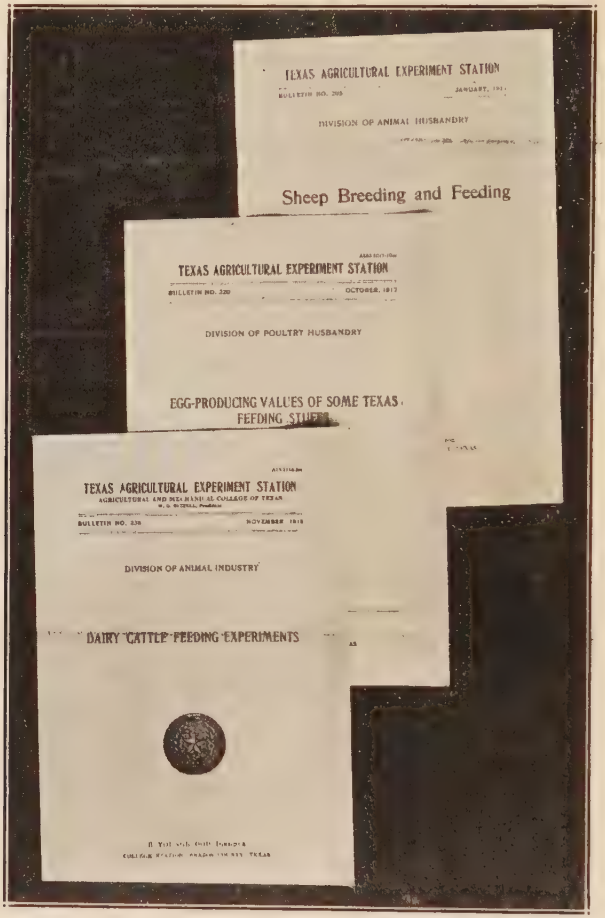
TILE DRAINAGE
TEXAS AGRICULTURAL EXPERIMENT STATION
The Productive Values of Some Texas Feeding Stuffs
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ANIMAL INDUSTRY
INFLUENCE OF PEANUT MEAL ON QUALITY OF PORK

**Tile Drainage:** The productivity of thousands of acres of land, especially in the southern and eastern parts of Texas, can be improved by tile drainage, especially after good surface drainage has been provided. Large areas of land in other States, known by reputation as our best producing agricultural lands, have been tile drained. If improper drainage handicaps your farm operations, read this bulletin and study your farm with the view to tile draining, if necessary.

**The Productive Values of Some Texas Feeding Stuffs:** This bulletin gives the nutritive values of different Texas feeds.

**Influence of Peanut Meal on Quality of Pork:** Soft pork dockage is costing the hog raiser much money annually. This bulletin deals with peanut meal as a feed and its effect on the quality of the pork. It pays to know what effect different feeds have on the quality of the meat produced, as otherwise you might unnecessarily stand dockage at the market.


TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ANIMAL HUSBANDRY
Sheep Breeding and Feeding
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF POULTRY HUSBANDRY
EGG-PRODUCING VALUES OF SOME TEXAS
TEXAS AGRICULTURAL EXPERIMENT STATION
DIVISION OF ANIMAL INDUSTRY
DAIRY CATTLE FEEDING EXPERIMENTS

**Sheep Breeding and Feeding:** Every farm should have its sheep, and certain problems of breeding and feeding naturally present themselves. This bulletin is a handbook of information on breeding and management of sheep.

**Egg-Producing Values of Some Texas Feeding Stuffs:** Different feeds stimulate egg production in poultry in different ways. This bulletin shows the results of feeding some Texas feeds for egg production.

**Dairy Cattle Feeding Experiments:** Know how to feed the dairy cow. It pays. Quality as well as quantity must be considered in the ration.

A9-1120-20M-L

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 24 NOVEMBER, 1920

DIVISION OF ENTOMOLOGY

# COMMERCIAL-SULPHUR PRODUCTS AS DORMANT SPRAYS FOR CONTROL OF THE SAN JOSE SCALE

B. YOUNGBLOOD, DIRECTOR,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

Figure 1. San Jose scale on peach leaf from an unsprayed tree, at Tyler, Texas, September 1, 1920.

Circular No. 24. November, 1920.

# COMMERCIAL-SULPHUR PRODUCTS AS DORMANT SPRAYS FOR CONTROL OF THE SAN JOSE SCALE.

By M. C. Tanquary, Chief, Division of Entomology, Texas Agricultural Experiment Station,
and
M. E. Hays, Horticulturist, Extension Service.

Lime-sulphur solution has long been recognized as the insecticide par excellence for the control of the San José scale. Owing to difficulties involved in preparing the home-made lime-sulphur mixture and the expense and trouble of handling the stock solution, a number of insecticide companies have recently placed on the market commercial preparations in the dry form. The manufacturers are recommending these products for the control of the San José scale.

These preparations have been tested by some of the different Experment Stations throughout the country and conflicting results have been secured. Some Stations have reported good control; others very little or no control.

Large quantities of these commercial products are being sold in Texas and in order to be able to give definite answers to numerous inquiries regarding the efficiency of these products the experiment described below was undertaken by the authors. It was planned to test a larger number of materials, but owing to various circumstances we were able to test only three this year. It is planned to test a larger number next year.

For the purpose of the experiment a peach orchard was secured in the northeastern part of the State, in the heart of the peach-growing district. The orchard belonged to Mr. P. T. Burns and is located about nine miles southeast of Tyler, Smith County, Texas. The orchard had been set out three years before and had never been sprayed. The scale had evidently been in the orchard for some time as a number of the trees were badly infested.

The sprayer that was used was an "Iron Age" barrel sprayer with a two-cylinder pump and a disk nozzle. A pressure of 175 to 200 pounds was maintained.

The date, February 24, was just about as late as a dormant spray could be applied in that locality. The fruit buds were swollen, many of them showing pink, and a few scattering blossoms were seen here and there in the orchard.

The spraying was done in the afternoon of a raw, chilly day. There had been a light misty rain in the forenoon. There was a light northwest wind.

The materials that were tested were Grasselli liquid lime-sulphur, Sherwin-Williams dry lime-sulphur, and Niagara soluble sulphur. These were used at the strengths recommended by the different companies; Niagara soluble sulphur, 12½ pounds to 50 gallons of water; Sherwin-Williams dry lime-sulphur, 15 pounds to 50 gallons of water; and Grasselli liquid lime-sulphur, 1 gallon to 8 gallons of water.

Two rows of trees were sprayed with each material and two rows left as checks, the relative locations being shown in the accompanying diagram.

| Niagara Soluble Sulphur | | Check Not Sprayed. | Sherwin-Williams Dry Lime Sulphur. | | Check Not Sprayed. | Grasselli Liquid Lime Sulphur. | |
|---|---|---|---|---|---|---|---|
| 1. Feb. 24. Very few scales. | 1. Feb. 24. Heavy infestation on east side of tree. Sept. 1. Excellent. | 1. Feb. 24. Moderate infestation. Sept. 1. Moderate infestation. | 1. Feb. 24. Very few scales. | 1. Feb. 24. Very few scales. | 1. Feb. 24. Heavy infestation. Sept. 1. Very heavy | 1. Feb. 24. Very few scales. | 1. Feb. 24. Heavy infestation on trunk. Very few scales on limb. Sept. 1. Excellent. |
| 2. Feb. 24. Very few scales | 2. Feb. 24. Moderate infestation on trunk. Sept. 1. Excellent. | 2. Feb. 24. Heavy infestation. Sept. 1. Heavy infestation. | 2. Feb. 24. Very few scales. | 2. Feb. 24. Very few scales. | 2. Feb. 24. Very few scales. Sept. 1. Heavy infestation. | 2. Feb. 24. Very few scales. | 2. Feb. 24. Very few scales. Sept. 1. Excellent. |
| 3. Feb. 24. Very few scales | 3. Feb. 24. Very few scales Sept. 1. Excellent | 3. Feb. 24. Very few scales Sept. 1. Very heavy infestation | 3. Feb. 24. Very few scales. | 3. Feb. 24. Very few scales. Sept. 1. Excellent. | 3. Feb. 24. Very few scales. Sept. 1. Moderate infestation. | 3. Feb. 24. Very few scales. | 3. Feb. 24. Very few scales. Sept. 1. Excellent. |
| 4. Feb. 24. Heavy infestation Sept. 1. Excellent | 4. Feb. 24. Very few scales Sept. 1. Excellent | 4. Feb. 24. Slight infestation. Sept. 1. Heavy infestation | 4. Feb. 24. Very few scales. | 4. Feb. 24. Very few scales. Sept. 1. Excellent | 4. Feb. 24. Very few scales. Sept. 1. Heavy infestation. | 4. Feb. 24. Very few scales. | 4. Feb. 24. Heavy infestation. Sept. 1. Excellent. |
| 5. Feb. 24. Heavy infestation. Sept. 1. Excellent. | 5. Feb. 24. Very few scales Sept. 1. Excellent | 5. Feb. 24. Very few scales. Sept. 1. Very heavy infestation. | 5. Feb. 24. Incrusted, except at tips. Sept. 1. Excellent. | 5. Feb. 24. Incrusted. Sept. 1. Excellent. | 5. Feb. 24. Very few scales. Sept. 1. Heavy infestation. | 5. Feb. 24. Very few scales. | 5. Feb. 24. Very few scales. Sept. 1. Excellent. |
| 6. Feb. 24. Moderate infestation. Sept. 1. Excellent. | 6. Feb. 24. Very few scales Sept. 1. Excellent | 6. Feb. 24. Moderate infestation Sept. 1. Tree dead. New growth free. | 6. Feb. 24. Very few scales Sept. 1. Excellent. | 6. Feb. 24. Very few scales. Sept. 1. Excellent. | 6. Feb. 24. Trunk and base of limbs incrusted. Sept. 1. Very heavy infestation. | 6. Feb. 24. Very few scales. | 6. Feb. 24. Incrusted. Sept. 1. Excellent. |
| 7. Feb. 24. Moderate infestation. Sept. 1. Excellent. | 7. Feb. 24. Very few scales Sept. 1. Excellent. | 7. Feb. 24. Heavy infestation. Sept. 1. Heavy infestation | 7. Feb. 24. Moderate infestation. Sept. 1. Excellent. | 7. Feb. 24. Heavy infestation at base. Few scales on small twigs. Sept. 1. Excellent. | 7. Feb. 24. Trunk moderately infested. Sept. 1. Very heavy infestation. | 7. Feb. 24. Very few scales. | 7. Feb. 24. Incrusted. Sept. 1. Excellent. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8. Feb. 24. Heavy infestation Sept. 1. Excellent. | 8. Feb. 24. Very few scales Sept 1 Excellent | 8. Feb. 24. Moderate infestation Sept 1 New tree* planted | 8. Feb. 24. Heavy infestation on trunk. Sept. 1. Excellent. | 8. Feb. 24. Heavy infestation Sept. 1. Excellent. | 8. Feb. 1. Heavy infestation on southside of trunk. Sept. 1. Incrusted. | 8. Feb. 24. Very few scales. | 8. Feb. 24. Incrusted. Sept. 1. Excellent. |
| 9. Feb. 24. Very few scales. Sept. 1. Excellent. | 9. Feb. 24. Trunk and base of limbs incrusted. Sept. 1 Excellent | 9. Feb. 24. Moderate infestation. Sept 1. Heavy infestation. | 9. Feb. 24. Slight infestation. Sept. 1. Excellent. | 9. Feb. 24. Slight infestation at base. Sept. 1. Excellent. | 9. Feb. 24. Trunk moderately infested. Sept. 1. Heavy infestation. | 9. Feb. 24. Heavy infestation. Sept. 1. Excellent. | 9. Feb. 24. Incrusted. Sept. 1. Fair. |
| 10. Feb. 24. Very few scales. Sept. 1. Excellent | 10. Feb. 24. Very few scales Sept 1. Excellent | 10. Feb. 24. Heavy infestation Sept 1 Very heavy infestation | 10. Feb. 24. Very few scales. Sept. 1. Excellent. | 10. Feb. 24. Slight infestation. Sept. 1. Excellent. | 10. Feb. 24. Very few scales. Sept. 1. Incrusted. | 10. Feb. 24. (Check) slight infestation. Sept. 1. Very heavy infestation. | 10. Feb. 24. Incrusted. Sept. 1. Good. |
| 11. Feb. 24. Heavy infestation. Sept. 1. Excellent. | 11. Feb. 24. Very few scales Sept. 1. Excellent | 11. Feb. 24. Heavy infestation Sept. 1. Heavy infestation. | 11. Feb. 24. Very few scales. Sept. 1. Excellent. | 11. Feb. 24. Heavy infestation. Sept. 1. Excellent. | 11. Feb. 24. Heavy infestation on trunk. Sept. 1. Very heavy infestation. Many scales on leaves. | 11. Feb. 24. (Check) slight infestation. Sept. 1. Heavy festation. | 11. Feb. 24. Slight infestation. Sept. 1. Excellent. |
| 12. Feb. 24. Moderate infestation. Sept. 1. Excellent | 12. Feb. 24. Very few scales. Sept. 1. Excellent | 12. Feb. 24. Very few scales. Sept. 1. Heavy infestation. | 12. Feb. 24. Slight infestation Sept. 1. Good. | 12. Feb. 24. Slight infestation. Sept. 1. Excellent. | 12. Feb. 24. Heavy infestation on trunk. Sept. 1. Heavy infestation. Tree dying. | 12. Feb. 24. (Check) slight infestation. Sept. 1. Moderate infestation. | 12. Feb. 24. Incrusted. Sept. 1. Excellent. |

*Tree died.

KEY TO DIAGRAM.

*Incrusted*—An actual incrustation of a large percentage of the tree.

*Very heavy infestation*—Scales very numerous on all parts of tree. Some parts of tree almost incrusted.

*Heavy infestation*—Scales very numerous, but not forming an incrustation.

*Moderate*—Scales fairly numerous throughout most of the tree.

*Slight infestation*—Scales scattered throughout the tree, but very easily found.

*Very few scales*—Scales found only by very careful searching.

*Excellent*—Perfect or almost perfect control.

*Good*—Good control, but some scales scattered throughout the tree.

*Fair*—Infestation very greatly reduced, but quite a number of scales still present.

A study of the above diagram will show that of those sprayed with Niagara soluble sulphur, twenty-one trees whose infestation ranged all the way from "Very few" to "Incrusted" on February 24, are all marked "Excellent" on September 1.

Of those sprayed with Sherwin-Williams dry lime-sulphur, two marked "Incrusted" on February 24 are marked "Excellent" on September 1; fifteen whose infestation ranged all the way from "Very few" to "Heavy infestation" on February 24 are marked "Excellent" on September 1, and one marked "Slight infestation" on February 24 is marked "Good" on September 1.

Of those sprayed with Grasselli liquid lime-sulphur, six were marked "Incrusted" on February 24. Of these, four were marked "Excellent" on September 1, one was marked "Good," and the other "Fair." The other trees sprayed with Grasselli liquid lime-sulphur whose infestation ranged from "Very few" to "Heavy infestation" on February 24, are all marked "Excellent" on September 1. It will be noticed that there are three trees marked "check" in one of the rows sprayed with Grasselli liquid lime-sulphur that were not sprayed. This was due to our running out of spray material before we reached the end of the row.

It will be noticed in studying the diagram that three trees sprayed with Niagara soluble sulphur, four sprayed with Sherwin-Williams dry lime-sulphur, and eight sprayed with Grasselli liquid lime-sulphur have no data recorded for September 1. This was due to the fact that the infestation was so slight in those cases that an examination of them would have yielded practically no results in comparison with the others and therefore all the available time was spent in an examination of the other trees.

Turning now to the check rows (not sprayed), one sees that there has been a very great increase in the amount of infestation, a number of trees increasing from "Very few" to "Heavy infestation" or "Incrusted." One tree had died, and another was in a dying condition. One tree had been removed and another put in its place. In no case was there a decrease in amount of infestation.

Figure 2 Spraying with lime-sulphur for control of San Jose scale, using power spray machinery Note the fan-shaped spray

## INTERPRETATION OF RESULTS.

The fact that infestation increased heavily on all the trees in the check rows while at the same time there was nearly perfect control in the case of the sprayed trees, shows that all three materials were very effective in controlling the San José scale under the conditions of this experiment. So far as we could determine, there was very little if any difference in the effectiveness of the three materials.

It is realized, of course, that this is only a preliminary experiment and that further tests should be made with such mixtures before final recommendations can be made. The results of this experiment, however, show very clearly the possibilities of commercial mixtures for the control of the San José scale under Texas conditions.

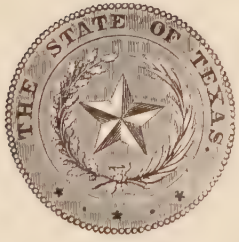
A24-121-25M-L

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 25 JANUARY, 1921

DIVISION OF ANIMAL INDUSTRY

# MANAGEMENT OF CHICKENS ON TEXAS FARMS




B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

Circular No. 25. January, 1921.

# MANAGEMENT OF CHICKENS ON TEXAS FARMS

By R. M. Sherwood, Poultry Husbandman,
Division of Animal Industry

## SELECTION OF STOCK

### BREED AND QUALITY OF STOCK

Texas is not a state of large poultry farms, but it is a state where most farmers have a number of hens. In some cases these are standard bred hens of good quality and suited to the needs of the farmer, while in other cases they are scrub or mongrel fowls. Before the farmer chooses the breed he desires, he first should decide whether he is more interested in egg-production than in growing a large-sized fowl for table purposes. When fowls are properly handled, there is, no doubt, more profit from the production of high-grade eggs than from the sale of table fowls. The producers who decide upon egg-production choose breeds similar to the Leghorn, the Ancona, and the Minorca, as these produce eggs at a lower cost per dozen than do the heavier breeds. The farmer who wishes a larger fowl, picks out chickens of the type of the Plymouth Rock, the Rhode Island Red, or the Wyandotte.

The particular breed selected is not so important as the breeding. There are good and poor flocks in all breeds. The producer will select stock of the correct shape and color for the breed and variety, and he should also see that they are from high egg-producing stock. The Kansas Experiment Station proved the advantage of the well-bred cockerels as shown in Table 1.

Table 1.

| | First Generation. | Second Generation. | Third Generation. |
|---|---|---|---|
| Egg production of pullets from cockerels of high egg-producing strains | 155.9 | 188.6 | 192.6 |
| Egg-production of pullets from common cockerels | 104.0 | 145.2 | 129.6 |
| Increase in egg-production by the use of good cockerels | 51.9 | 43.4 | 63.0 |

This advantage amounted to from about 3½ dozen to over 5 dozen eggs more per year from all the pullets from the high-producing cockerels than from the common ones. If one figures these eggs at 30 cents a dozen, the advantage in favor of the good cockerels would be from $1.09 to $1.57 for each pullet sired by them.

Figure 1 shows Texas No. 4, a pedigreed hen with a record of 261 eggs from December 13, 1919, to December 13, 1920. This is her second laying season. She was not trap-nested during her first laying season;

therefore, it is impossible to say just how many eggs she laid. Hens regularly lay more eggs during their first year than their second year. Figure 2 shows the pedigree of the sire of this hen, and Figure 3 shows her second year's egg-record. On January 19, on November 17 and November 21, she laid 2 eggs, and on April 8 she laid a double-yolked egg. Hens with such breeding often lay when they are molting or molt in a very short time. Texas No. 1, a hen of similar breeding to Texas No. 4, laid 166 eggs from December 6, 1919, to August 6, 1920, in her second laying season. She then molted completely and was back laying on October 10. She laid 197 eggs during her second year. These are illustrations of the performance of two pedigreed hens at this Station, but they show the results to be expected from such stock elsewhere.

It is recommended to the producer that he decide upon one breed,

Figure 1. Texas No. 4. This hen laid 261 eggs during her second laying year.

and that each year he secure well-bred cockerels of this breed to mate with his flock. It is also advisable for these to be from the same strain if possible.

## CULLING

It is recommended that the farmer cull out both his poor hens and his old ones. It has been found that the hens that stop laying and molt early in the season are the poorer layers. If a number of hens stop laying early in the season, it may be advisable to cull several times during the year. The poor layers can thus be removed as fast as they are detected. A laying hen is wide between the pelvic or lay bones, and she is deep and full in the abdomen. The vent is large and moist and free

# Pedigree of 103E

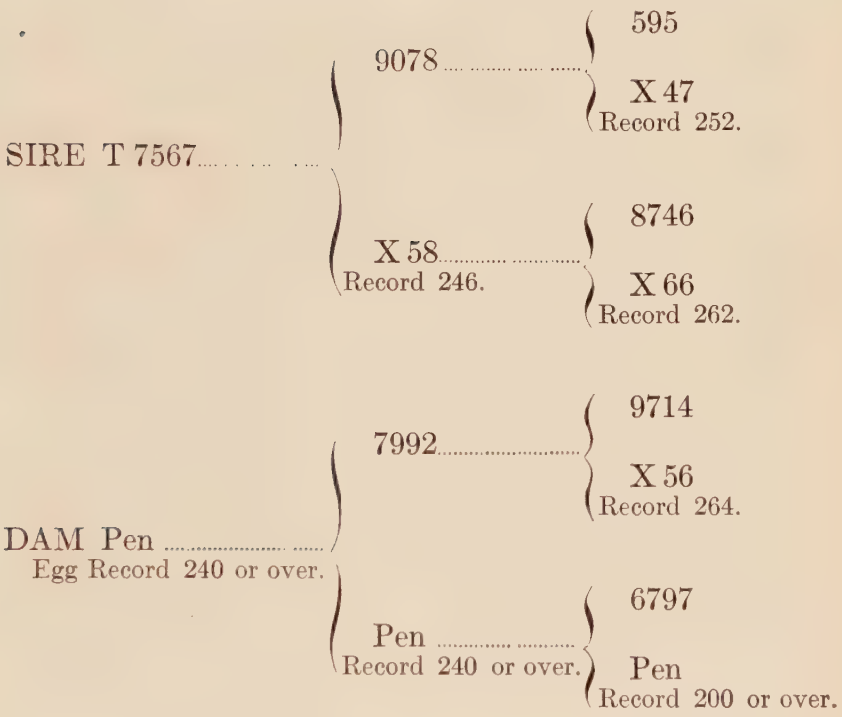



FIGURE 2. Pedigree of Sire of Texas No. 4.

LAYING YEAR Second
MATING NO. 103E678

# INDIVIDUAL EGG RECORD

YEARS 1919 TO 1920
BAND NO. 4
BREED Leghorn

HATCHING DATE May 7 1918 BEGAN LAYING Dec. 13 1919 AGE AT FIRST LAYING

| DATE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | DAYS TOTALS MONTH | DAYS TOTALS TO DATE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dec. | | | | | | | | | | | | | ★ | ★ | | ★ | ★ | ★ | ★ | | ★ | ★ | | ★ | ★ | | ★ | ★ | ★ | ★ | | 14 | 14 |
| Jan. | ★ | ★ | ★ | | ★ | ★ | ★ | | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | | ★ | ★★ | ★ | ★ | ★ | | ★ | ★ | ★ | | ★ | ★ | | ★ | 25 | 39 |
| Feb. | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | | ★ | | | 24 | 63 |
| Mar. | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | | ★ | ★ | | | | | | | | | | 18 | 81 |
| Apr. | | | ★ | ★ | | ★ | ★ | (8) | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | | ★ | ★ | ★ | ★ | | 24 | 105 |
| May | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | 28 | 133 |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | | |
| June | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | | ★ | | ★ | ★ | ★ | ★ | ★ | | | ★ | | 25 | 158 |
| July | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | | ★ | ★ | ★ | 26 | 184 |
| Aug. | | ★ | ★ | | ★ | | | ★ | ★ | | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | ★ | 23 | 207 |
| Sept. | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | | ★ | ★ | | ★ | ★ | ★ | ★ | ★ | ★ | ★ | | | ★ | | ★ | ★ | | ★ | | | ★ | | 21 | 228 |
| Oct. | ★ | | | ★ | ★ | ★ | ★ | | ★ | | ★ | ★ | | ★ | ★ | ★ | | ★ | | ★ | ★ | ★ | | ★ | | ★ | | ★ | ★ | | ★ | 20 | 248 |
| Nov. | | | ★ | | ★ | | ★ | ★ | | ★ | ★ | | ★ | ★ | | ★ | ★ | | | | ★ | | | | | | | | | | | 13 | 261 |
| Dec. | | | | | | | | | | | | | | | | | ★ | | | | ★ | | | | | | | | | | | XXX | 261 |

PREVIOUS RECORDS 1ST XXXX 2ND 261 3RD
4TH 5TH 6TH

MATED TO 2 M

REMARKS On April 8, she laid a double-yolked egg.

YEAR'S RECORD 261

Figure 3. Second year's egg record of Texas No. 4

from yellow color. The comb is large and waxy. It is bright red in color and warm to the touch. The comb of a hen after she has stopped laying for any length of time decreases in size and is covered with white scales. It is also cold to the touch.

In hens with yellow coloring on the legs and beak, the poorer layers retain this color, while it disappears in the case of the good hens. If a hen is laying in September and shows no indication of being a poor hen otherwise, she should be kept another year. Hens should not ordinarily be kept until they are over two or three years old unless they are known to be extra good layers.

### VIGOR AND FREEDOM FROM DISEASE

Too much emphasis cannot be placed upon the vigor and the general health of the flock. A chicken of low vigor is long and narrow about the head and shallow and narrow in the body. Fowls of this type are more susceptible to disease than those that are wide and deep in head and body. The type is transmitted from one generation to the next; therefore, it is very important that the breeding flock contain only fowls of the good type.

### NUMBER OF HENS TO MATE WITH ONE MALE

The number of hens to mate with one male varies with the individuality of the male, with the size of the flock, with the range that the flock has, and with the general type of the fowls. With fowls of the type of the Leghorn, the Ancona, and so forth, from 20 to 30 females are placed with one male with good results. With breeds of the type of the Plymouth Rock, the Rhode Island Red, and the Wyandotte, probably 15 to 20 will give better results. Often good results are secured when larger numbers of hens are mated with one male, but too much depends upon the individual birds to make it wise to recommend more than these numbers.

## HATCHING THE CHICKS

### CARE OF EGGS FOR HATCHING

The eggs should be gathered often when the weather is cold to prevent their being chilled. They should be carefully culled, and all dirty, extra large, small, cracked, bad-shaped and otherwise defective eggs should be discarded. It is often advisable to candle the eggs at this time. This treatment will show a number of small cracks and otherwise defective shells that might not be seen until after the eggs are set. If possible, the eggs that have been selected for hatching should be kept at a temperature of from 45 degrees to 65 degrees Fahrenheit.

Eggs should not be held for hatching longer than is absolutely necessary. Good results are sometimes secured with eggs held as long as two weeks when they are held at a temperature of from 45 to 65 degrees and are turned once a day.

### INCUBATORS OR HENS

The incubator has the advantage over the hen in that it "will sit" whenever the owner wishes it to, while the hen sits when she gets ready.

Since the early hatched chicken does better than the late hatched one, it is generally advisable to use a machine. Incubators run steadiest when operated in basements. When a basement is not available, people sometimes experience trouble with some machines in keeping up a steady temperature under all conditions. For this reason commercial hatcheries are starting up in different sections of the state. These hatcheries are properly equipped to hatch and sell chicks, and in some cases to hatch the farmers' eggs for them.

### TYPES OF INCUBATORS AND OPERATION

There are two general types of incubators, based on how the heat is carried from the lamp to the hatching chamber. These are called hot-water and hot-air incubators. Both types will give good results if properly handled.

It is advisable to follow the instructions sent out with the incubator at first. It must be remembered, however, that the conditions in the Texas homes may be different from those where the machine was tested and the directions were written. For this reason it may be necessary to make slight changes in the method of operating the machine.

It is advisable to see that the machine is level, and that it occupies a position in the room where it will be free from drafts and where the sun cannot shine upon it.

The thermometer and heat regulator should be thoroughly tested. If the thermometer is not accurate, the machine may be operated at the wrong temperature, even though the thermometer indicates that the temperature is correct. The thermometer may be tested by passing it back and forth along with a tested thermometer in a pail of water heated to a temperature of 103 to 105 degrees. If the readings of both thermometers agree, the thermometer is accurate. This test should be made each year, as the thermometer is often injured when not in use. The heat regulator is best tested by heating up the machine and by operating it for a week or so. If the machine runs at a steady temperature, the regulator should be satisfactory. This test should be made each year, and should be made long enough before the incubator is to be used to secure repairs if necessary.

### HEN HATCHING

Those who use hens to hatch the chicks should have some well ventilated place in which to set the hens, and a place where the laying flock will not bother them. If it is possible to make this room fairly dark, so much the better.

Nest boxes 16 inches to 18 inches square are best suited. They should not be over 8 inches or 10 inches deep, as hens break more eggs when deep boxes are used. The nest should be tight at the bottom to prevent the eggs from drying too rapidly. Often dirt or sod is placed in the bottom of the box and the nesting material is placed on it.

The hen is rendered free from lice by dusting her thoroughly on the neck, back, thighs, under the wings, and about the breast and vent with a good louse powder. Sodium fluoride is one of the best powders. A second treatment may be used after the hen has sat one week. It is

necessary that the hen and nest be watched carefully for mites. These pests increase rapidly and often kill a hen or cause her to leave the nest. In case they appear, it may be necessary to remove the hen and eggs to another nest. It may also be necessary to dip the hen in a 2 per cent. solution of a good stock dip to kill the mites on her.

The feed for a sitting hen should be very simple. Milo, kafir, or corn with plenty of fresh water is all that is needed. She should be attended to every day. If the eggs should become badly soiled, they may be washed with warm water.

## REARING CHICKS

It is necessary to furnish incubator-hatched chicks with some means of keeping them warm. On some occasions the coal-heated hover is used, while in other places the kerosene-heated hover is preferred. Both have their advantages and disadvantages. They are operated in small houses or rooms that can be closed sufficiently to keep the chicks warm during cold weather, but that can be opened enough in warm weather so that the chicks will not become overheated.

### OPERATION OF THE BROODER

The brooder and house should be thoroughly disinfected with a 5 per cent. solution of a good stock dip several days before the chicks are hatched. The heater should then be started and the house thoroughly dried out before the chicks are ready to be taken from the incubator. The floor should be covered with a fine litter, and the hover should be warmed to a temperature of 100 degrees Fahrenheit before the chicks are placed under it. For the first few days the chicks should be kept near the heat by placing a small mesh wire netting around the brooder. If rats are troublesome, the entire room will need to be screened to keep them out.

The routine of operating a brooder consists of the care of the heater, frequent and thorough cleaning under the hover, and, in case of sickness, careful disinfection. Any dead chicks should be buried deeply or burned. Sick ones should be killed as the chances of their making a satisfactory recovery are slight, and there is danger of their communicating the disease to the rest of the flock.

As the chicks grow older and learn to go on the roost at night, they need less protection from the weather. It is not advisable to allow them to become overheated in the early part of the evening and then cool off quickly as the night becomes cooler. Such management causes colds which often develop into roup. In many cases it is satisfactory to allow the chicks to roost out in the open. In other places it is necessary to protect them from enemies. Often a building which is open on the sides and ends, and which is enclosed with wire netting, is used with complete success.

## POULTRY FEEDING

There are two ways to feed: one is to feed for maximum production; the other is to fed for maximum profits. These two may be alike, but this is not always the case. For instance, under certain care a flock

may be yielding an annual income of $3.10 per fowl with an expense of $1.60, and thus may be yielding a profit of $1.50 per year. The feeder may buy certain feeds at high prices and increase the income to $3.25; but if he increases the expense to $1.80, there will be a profit of only $1.45. Therefore, a farmer who has grown certain feeds and who values them at what they will bring on the market, should not and will not buy other feeds at higher prices unless the returns are high enough to pay for more than the added cost. On the other hand, the man who buys all his feeds from feed stores may find it profitable to buy some feeds that the farmer would not find it profitable to buy. In figuring rations the feeder should keep these points in mind and feed a ration for the greatest profit, whether it gives the highest production or not.

## FOOD NUTRIENTS

Proteins are nutrients found both in vegetable and animal feeds. The proteins are very necessary for growth and for egg-production, and if the feeds given are lacking in them the results are not satisfactory. The protein from animal sources is most valuable for poultry. It is not necessary, however, that all the protein in the ration should come from animal sources as the poultry can use some vegetable protein with good results.

Carbohydrates and fats are two nutrients which are somewhat alike. Fats are more concentrated than carbohydrates; they contain 2¼ times as much energy as do carbohydrates. Carbohydrates in the feed may be changed to fats in the body or in the product. Neither of these can be changed to protein in the body or in the product.

Ash or mineral matter is another group which is important. Both eggs and chickens contain larger amounts of certain kinds of mineral matter than are found in the grain feeds. Therefore, special attention should be given this fact in order to produce more profitable growth and egg-production.

## FEEDING GROWING CHICKS

The growing chicks require large amounts of protein and ash to form flesh and bone; also, carbohydrates and fats to produce the necessary body heat and energy, and to produce some fat. In order that the chick may make most satisfactory gain, it should receive feed containing each of these food nutrients. The table below shows clearly the feeds that most efficiently do this.

Table 2

| Protein Feeds Produce Flesh. | Ash Feeds Produce Bone. | Carbohydrates and Fats Produce Heat, Energy, and Fat. |
|---|---|---|
| Sour skimmed milk. | Ground bone. | Cracked corn. |
| Buttermilk. | Bran. | Cracked milo. |
| Meat scraps. | Milk. | Cracked kafir. |
| Fish meal. | | Cracked wheat. |
| Bran. | | Oats without hulls. |
| Shorts. | | |

Of the grains given in the table, corn, kafir, and milo have the smallest amount of protein and ash, while wheat is second, and hulled oats are first in these nutrients. Thus, in chick-feeding if most of the grain fed is cracked corn, kafir or milo, the chicks must be given more feeds rich in protein and ash than if more wheat and hulled oats are fed.

Where corn, kafir, or milo, is available for use with wheat and oats, the grain ration may be of equal parts by weight of each of the three used. For young chicks the corn, kafir, milo, and wheat should be finely cracked, while the oats used should be steel cut or rolled oats. As the chicks become larger, coarser cracked grain may be used. When they become half-grown, the grain need not be cracked, and heavy oats may be used in place of the steel cut oats. The proportion then may be corn, kafir, or milo two parts, and oats one part by weight.

Although bran and shorts are given to the chicks to supply protein and ash, they do not furnish sufficient quantities and they do not afford all of the kinds of protein necessary. For this reason sour skimmed milk or buttermilk or meat scraps should be fed. Of these feeds, the milk is better than the meat scraps. The milk should be kept before the chicks at all times. The dishes should be scalded often to prevent poisonous molds from growing in them. Care should be taken not to spill the milk on the ground as this often breeds diseases. The bran and shorts may be fed with some finely ground corn, milo, or kafir in the proportion of two parts bran, one part shorts, and two parts ground corn, milo, or kafir. If milk is not available, one part of high-grade meat scraps or fish meal may be added to this mixture. Dry ground bone may be kept in a hopper or it may be mixed with the above feed in the proportion of one pound of bone to fifteen pounds of the above feed.

A large number of chicks are lost each year because they are fed too much the first week. They should first be fed when 36 to 48 hours old with a little grit and with a small amount of hard boiled egg mixed with rolled oats or bread crumbs; and they should be given all the milk or water they will drink. The second day a small quantity of the grain feed recommended above should be given, together with a small amount of the bran mixture. The first week the chicks should be fed often but only in small quantities. A chick fed often but only two-thirds what it would eat the first week does much better than a chick which is fed heavily at this time. This is so because the digestive organs are not completely developed before the end of the week.

When the chicks are half-grown and on range, they may be fed in self-feeders. These should be used some distance from the roosting house in order to encourage the chicks to exercise.

The practice of throwing out too much feed has the result that the chicks soil it and eat filth with it. This causes disease. On the other hand, the feed may sour and mold and injure the chicks still worse. Another thing that should not be overlooked is that filth attracts flies, which often carry tapeworms. These tapeworms spend part of their lives in the flies and the other part in the chicks. Therefore, if the chicks eat flies containing these tapeworms they will be infected by them. In the case of tapeworms the loss may not come for several weeks, as it takes some time for the worms to develop.

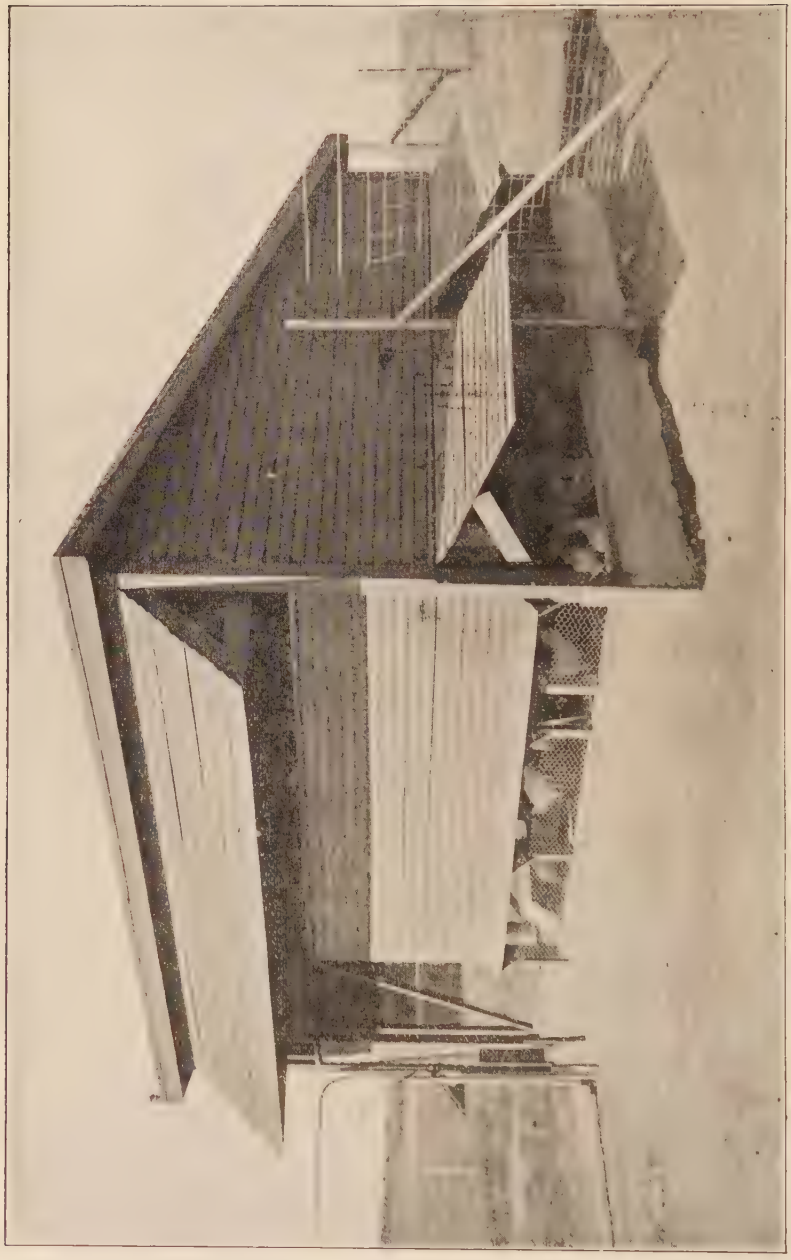


Figure 4. Poultry house that is very satisfactory at College Station.

### FEEDING FOR EGG-PRODUCTION

Feeding hens for egg-production is not very different from feeding chicks. The feeds that were used by the chicks to produce flesh will be used by the hens to produce the white of the eggs and part of the yolks. The feeds used to furnish the chicks with heat and energy, and to produce fat, will be used by the hen to furnish heat and energy, and to produce part of the yolk of the egg. Ash feeds will be used to produce the shell of the eggs.

Feeds for egg-production may, for convenience, be classed as grain and mash feeds. About one-third of the grain is fed in the morning in a deep litter of straw or other similar material. This method makes it necessary for the fowls to secure exercise as they get this food. The remainder of the grain feed, preferably that with larger sized particles such as corn, may be fed at night. When corn, wheat, barley, and oats are available, this ration,—one-half by weight of corn and the other half barley or wheat or heavy oats,—is recommended. Milo, kafir, or feterita, being quite similar to corn, may be used as a substitute.

The mash feeds are kept before the fowls at all times. A satisfactory mash ration may be made of equal parts of bran and shorts with 1 per cent. of salt and 20 per cent. of meat scraps or fish meal, or with 15 per cent. of high grade meat meal or tankage. If the chickens have all the sour milk or buttermilk they can drink, it is not necessary to feed any meat feeds.

Green feed should be grown for the fowls at all times. It furnishes certain food materials that are not found in the grain or meat feeds. Sprouted oats and roots furnish succulence but do not furnish this special food material given by growing grasses.

Oyster shells are necessary for best results. Clam shells, often called poultry shells, are not so satisfactory. The hens do not eat them so readily as they do oyster shells.

Water should not be neglected. About two-thirds of the egg is water, and the body of the hen requires still larger quantities. If it is not given, the hens will not lay well.

It does not pay to underfeed hens in winter or in summer. They should get all the feed they can use. This, of course, should not be given without compelling the hens to exercise for it. They should also be compelled to search for as much feed on the range as is possible.

## HOUSES FOR THE LAYING HENS

Texas Experiment Station Bulletin No. 207 deals with housing; those interested should secure it. The housing conditions in the state vary greatly. It is therefore advisable to write to the Experiment Station concerning definite questions on this subject. In all sections of the state the houses should furnish protection from the wind and storms. They should be so built that they will be cool in summer without having drafts blow on the fowls. The house should be constructed so that it can be thoroughly cleaned and disinfected.

The chicken tick, or blue bug, and the chicken mite both seek cracks and crevices. A thorough application of carbolenium 2 parts and kerosene 1 part is most satisfactory for these pests. This may be applied

with brush or spray pump. Lice may be controlled by dusting the chicken thoroughly with sodium fluoride. During warm weather the chickens may be dipped in the following mixture:

| | |
|---|---|
| Sodium fluoride | 1 oz. |
| Sulphur | 2 oz. |
| Soap | 2 oz. |
| Water | 1 gal. |

This mixture gives the best results when it is heated to a temperature of about 80 degrees.

Figure 4 shows a cut of a house that is giving good results at College Station. In some sections of the state it would be advisable to have more of the front open. The ventilation at the floor makes this house very cool in summer.

Figure 5. Method of marking eggs to be marketed by egg circles.

## MARKETING

During the hot months the egg market in Texas is very poor. Those who produce a good grade of market eggs should receive a fair price for them. A system of marketing has been built up in certain parts of the state by the Extension Service of the Agricultural and Mechanical College of Texas. It is known as the Egg Circle Egg Market. The producer agrees to market infertile eggs, to market often, and to take special care of the product. He then has permission to stamp his eggs as shown in Figure 5. He thus is in a position to secure more for the eggs than he would otherwise. More information on this subject may be had upon request.

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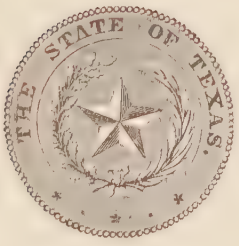
TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 26 DECEMBER, 1920

DIVISION OF FARM AND RANCH ECONOMICS

# COST OF PRODUCTION; ITS RELATION TO PRICE

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COLLEGE STATION, BRAZOS COUNTY, TEXAS

Circular No. 26. December, 1920.

# COST OF PRODUCTION; ITS RELATION TO PRICE

By A. B. Cox, Ph. D., Chief, Division of Farm and Ranch Economics.

It is the purpose of this discussion to state clearly and concisely the fundamental economic principles involved in the determination of the relation between cost of production and the price of agricultural products, and to give a brief analysis of the ways the farmers and ranchmen may meet the present situation to their best present and future economic advantage.

## TERMS DEFINED AND DESCRIBED.

*Cost of Production* is frequently thought of as meaning one of three things. (1) *More strictly speaking, the term "Cost of Production" applies to the labor, the pain undergone either in producing or in waiting for the fruits of toil.* It is in this sense that it is used by those who speak of cost of production in terms of long hours, hard work, isolation, lack of social opportunities, such as school and church advantages, and lack of home conveniences, like sewerage, lights, running water, etc., that may be had in the city. (2) *Cost of Production may be used in the sense of opportunity cost.* Opportunity cost means that if the farmer were not doing this he could be doing something else. The farmer, especially his son, may become a mechanic, doctor, or one of a hundred other things instead of a farmer. The idea is that there are no differences in ability required, and probably no difference in the preparation needed, or the pleasure gotten out of the work. (3) *Cost of Production* is more frequently used in the sense of *expense of production, i. e., money cost.* This means that it has cost the farmer so many dollars to produce a bale of cotton, or a calf. Cost of production used in this sense includes every expense of whatever nature, whether overhead or operating expenses, necessary to obtain the product. It includes all such items as interest on capital invested, depreciation, labor costs, both hired and that of the manager and his family, cost of seed, fertilizer, etc.

It is in the sense mentioned last that the term "cost of production" is used in this paper. However, the two costs mentioned first are real costs, and should be carefully weighed when one is selecting an occupation.

## WHAT IS PRICE?

Ordinarily when one speaks of the price of a given commodity he has in mind the amount of money given per unit; i. e., per pound, per bushel, etc., for it, and is properly called market price. The word market may be defined to mean several different things. Frequently it means the place where buying and selling takes place. It may refer to price levels as when one says the market is up or down. In this

paper *a market means the field in which the forces which determine the price of any particular good operate.* The amount of fresh milk in Wisconsin has nothing to do with the price of fresh milk in, say Dallas, Texas. The forces which determine the price of milk do not operate over so wide a territory except indirectly. The amount of cotton in Texas, on the other hand, has a very decided influence on the price of cotton throughout the world. It is said that the forces which determine the price of such products as cotton, wool, grain, and to a more or less extent, live stock, are world wide. A large crop in any part of the world influences prices in all other parts. Likewise, anything like a war or panic that affects the demand in one section has its corresponding effect in every corner of the world market.

*Market price is concerned with commodities already produced, and that are being offered for sale.* Agricultural products whose prices are determined by world-wide forces are sold on grade, and, within a given grade, units are freely exchangeable. Once in the market the units are completely detached from cost, and their price is determined by the number of such units offered, and the size and intensity of the demand for them. Market price is determined by the higgling of buyers and sellers. If the sellers are not organized to control the orderly disposition of the supply they may depress their own market by excessive competition with each other. Such a situation has worked unusual detriment to the producer under present market and financial conditions. Indeed, the present market is what is usually called a buyers' market. The belief is almost universal, even among the sellers, that prices will continue to go down. Such a condition makes the sellers anxious to turn loose, and the buyer extremely cautious, hoping to stay out until the market has reached its lowest point. Such a situation is forcing prices to lower levels than they would normally go.

Price is sometimes used to designate what is known as *Normal Price.* It is called the long time price. It is the price around which market price fluctuates. It is the cost of production price. People who speak of the "natural price," of the "just price," have in mind what is here designated as normal price. It must be noted that normal price as here used is not a sales price like market price. Normal price, cost of production, and market price can never correspond exactly, though they tend to, because of the differences in costs and because of unforeseen changes in demand. If market price is far below normal price then enough producers will quit producing to shorten the supply and drive the market price up. If market price is too far above expense of production, normal price, other producers will come in until the added supply forces the price down.

Cost of production is an influence affecting the supply of a commodity, and influences market price only to the extent that it modifies the supply. Cost cannot modify supply already created. Cost above market price lessens future supply and raises future price. Therefore, the main service of cost of production figures for the farmers and ranchmen are to indicate to them the crops that are most profitable, and the best organization under which to produce them.

Producers of non-perishable goods, like cotton, who are sufficiently well organized to hold their commodities off the market, and at the same time control the creation of a further supply, may, by withholding a part of the supply from the market, force the market price to

higher levels. They do it not by setting price, but by limiting and regulating the supply.

### EXPENSE OR COST OF PRODUCTION AS THE BASIS OF PRICE FIXING.

Cost of production of any commodity like cotton, wool, and live stock is not one thing, it is many things and may be almost anything. It is safe to say that the cost of production of cotton in Texas this year has varied from as low as 10 cents per pound to as high as $1.00 or more in some boll weevil infested districts.

Which figure should be chosen for the purpose of price fixing? It may be said that neither extreme should be taken, that the average cost of all the costs should be the one chosen as the price. In that case it is possible that half of the growers will have to sell at a loss. They would be justified either in demanding a higher price, or, if they did not get it, in quitting the business. The next year, if the average cost be taken, it would probably eliminate half of the remaining producers. Obviously, such a procedure is impracticable and undesirable.

According to a survey made by the Office of Farm Management and Economics in the U. S. Department of Agriculture of seventy-five farms in Ellis County, Texas, the cost of producing cotton varied from fourteen cents per pound to as high as thirty-four cents. The same survey shows that in Rusk County, Texas, the variation on seventy-five farms was from twelve cents to fifty-two cents per pound.* These extremes would by no means measure the extremes this year were the figures gathered from the entire state.

The cost of production studies that have been made show that, while there are the extremes noted above, the bulk of any commodity like cotton is produced at a cost that does not vary over wide ranges in any particular year. Therefore, if the cost of supply were the only factor determining price, the regulation of price would be a comparatively simple matter. The demand is probably as important a factor in setting price as the cost of the supply. Suppose there are not enough buyers to take all that is offered for sale at a given price? One of three things must happen, either the price must be lowered to tempt more buyers, a part of the supply must be withdrawn, or some other means like inflation used to bolster up prices. The last alternative is of very doubtful advantage. The demand for most products is subject to as wide fluctuations as the cost of producing them. The manufacturers organizations spend large sums of money in an effort to gage and influence future demand. Why should not the farmers organizations do the same thing? Farmers are now producing for the market just like the manufacturers.

There are many schemes of adjusting price to cost of production. The problem has become especially acute in the whole-milk districts around the large cities. Both producers and distributors have been thoroughly organized, and the cost principle of price making thoroughly tested. They have found the cost to vary so widely that it was impracticable to use it as a basis of price making, other than as an indication of bargaining ability. The most satisfactory arrangement devised so far has been to set a price that is calculated to draw out the

*"The Cost of Producing Cotton." Bulletin No. 896 of the United States Department of Agriculture.

necessary supply. While the field in which the price determining forces are operating to determine the price of milk is very narrow, yet, even here, price adjustments must be made monthly for best results.

Where price determining forces are world wide, no system of price setting has been found at all workable. The most reliable criteria yet devised upon which the producer may predict future prices is the future market. Most farmers readily agree that that is not a very safe basis upon which to calculate. Any adequate study of the market involves both an analysis of the cost of the supply and the source and strength of the demand. The farmers and ranchmen may be sure, however, that the price of any staple agricultural product will not remain long below the cost of production of the bulk of it. If they keep their costs within the proper bounds their chances of profit will be greatly increased.

## MONOPOLY PRICES.

The above economic laws apply only where goods are reproducible and are sold under conditions freely competitive. Such competitive conditions obtain on the supply side in the sale of the staple agricultural products. *Monopoly price is that price that will yield the greatest net return to the seller.* Cost of production has nothing to do with monopoly price, except as a basis from which to calculate profits. The monopolist does not set the price except indirectly. He limits the supply and competing buyers set the price. Certainly one would have to travel a long way to find such conditions of price making among the producers of agricultural products.

## THE ECONOMIC PROCESS IN THE PRODUCTION OF FARM CROPS.

Time was when the farmer was little disturbed by changes in price, or other economic conditions. He practiced a more or less self-sufficing agriculture. His surplus, when he had one, was sold in the local village to buyers for immediate consumption. He could know about what the local price would be months in advance for it was not disturbed by outside competition. Conditions have changed immensely from that day to this. The farmer has become a business man, and must have a substantial money income. He spends large sums of money for land, labor, and equipment to produce a commodity for the market just the same as a manufacturer. One speaks now of farmers and ranchmen going broke just as he speaks of merchants going broke. Economic considerations have become the factors of prime importance in agricultural production. Farming has become more specialized. The farmers and ranchmen are producing for a market which is very different from what it was formerly. Costs of production and prices have become facts of major importance in the economy of the farmers and ranchmen.

Farmers and ranchmen have attempted to meet their need for a greater money income by adopting many devices looking toward increased production. The enormous increase in agricultural products per farmer is ample proof of their success in this field. Have they studied equally as well the commercial side of the business? Their present plight tells its own story. The market for staple agricultural products has become world-wide. The producers of cotton in Ellis County, or of wool in Sutton County, are producing to sell. They must

find buyers in every country in the world, and they must meet competitors in the market from every country. In order to handle their business efficiently, the producers must know the factors effecting the demand for their products, and the sources of supply. If the ranchmen had facilities for keeping themselves informed on these points they would not have paid $25.00 to $30.00 for ewes to produce 20 cent wool. If the farmers had known of the uncertainty of the demand for cotton they would not have to be selling cotton for less than half it cost to produce it.

The time has come when the farmers and ranchmen must devote more study to the commercial side of their business. Colleges, as well as farmers' organizations, must attack these problems with increasing vigor if the farmers and ranchmen are to prosper as they should.

The consideration of prime importance in the production of any crop for the market is the anticipated price. The anticipated price is, by most producers of agricultural products, based on the existing price plus the general price trend. There are ways of calculating the possible price that are more reliable, but they have been out of reach of the majority of producers. They must be made available, even though they furnish only a basis for conservative estimates.

The second consideration is the probable cost of production. This, too, has been calculated on the prevailing prices at the time the crops are projected plus an anticipated change due to the trend of prevailing prices. The producers must know others' cost as well as their own.

With anticipated prices and costs in mind the farmers must be able to weigh accurately the relative profitableness of the various crops available in their particular cases. In fact, this is perhaps the most important consideration in all cost calculations of the individual producers. Because of the nature of the business the farmers and ranchmen cannot afford to quit producing entirely. Moreover, the cost of land, labor, and equipment is about as expensive for the production of one crop as for another. Therefore, the problem of the farmers and ranchmen is to use their available land, labor, and capital to get the maximum value in product and security per unit of expenditure. It means a more efficient use of the factors of production than is ordinarily attained in a one-crop system, whether of cotton or cattle. On the basis of his calculations the farmer should produce cotton, corn, hay, or other crops, or a combination of crops and animals.

### SOME PECULIAR PROBLEMS OF THE PRODUCER OF LIVE STOCK.

The producer of live stock is not so fortunate as the producer of cotton for it is virtually impossible for him to store his crop, or to shift very materially his line of production. An animal fattened for the market must be sold almost regardless of price. When animals are finished in the feed lots they must be sold whether they bring even the original purchase price. The marketing of range animals may usually be spread over a longer period of time, but even here it is impracticable to hold much beyond the time the animals reach their best marketing condition, and it is dangerous, indeed, to keep such animals much past the time of the arrival of the next animal crop, especially if the man has his range stocked to normal capacity. His stock will decline in flesh and he will run the additional risk of great losses should a drought appear.

On the side of production the ranchman's problems differ materially from those of most farmers. Ranching is not a business one can go into or quit on short notice without the possibility of great loss. It takes time to get into the ranch business as a producer. One has to wait longer for his returns. Once in the business as a producer it is hard to get out and avoid a loss. The better ranchmen have spent years developing a type of animal suited to their needs. Should they sell now they would not only lose their present organizations, but they would have to sell at a great sacrifice. But as long as the ranchmen keep their stock there will be very little change in their output of animals and wool and mohair. The adjustments in ranching take place more slowly than in crop raising.

## STATISTICS ON THE RELATION OF PRICES TO SUPPLY.

Since 1866 the price of corn (the average farm price December 1st) has varied inversely with supply forty times and directly with it in thirteen instances. In the instances where prices went up with increased supply the varation in the supply was not very great, and in 1892, when the supply fell almost 500,000 bushels, prices registered a decline. The crop of 1893 was still shorter but a further decline in price was registered. The panic which occurred at this time had a greater influence on price than the supply of the commodity itself. The other outstanding exceptions were the years from 1914 to the present. Corn prices, like most other products, have risen since 1914 regardless of supply. Inflation was unquestionably the big cause of the rise in this last instance.

What has been said of corn prices apply equally as well to wheat. The price varied inversely with respect to supply thirty-five times and directly with supply eighteen times since 1866. In the case of potatoes we have the least disturbances of market due to foreign influences. Prices have varied inversely with supply forty-eight times since 1866 and directly only five times.

Cotton prices have varied inversely with supply twenty-nine times since 1875 and directly thirteen times. In four out of the thirteen cases there was no variation in price. The direct variations do not occur at the same times as the direct variations of other articles mentioned above. The greatest periods of direct variations were from 1888 to 1891 and from 1900 to 1903. This tends to show that neither the supply nor the general condition in our country controls price, but that European and Asiatic conditions are important factors. The unusual decline that has taken place in recent months is due not so much to conditions in our own country, as to the conditions in foreign countries, especially Europe.

## CAUSES OF THE PRESENT PRICE SITUATION.

The Yearbook of the U. S. Department of Agriculture for 1914 shows that three countries produce the bulk of the fourteen million bales of cotton that constitute the export trade of the world. The United States furnishes beween nine and ten million bales of this, British India about two million, and Egypt about one and a half million. The bulk of this cotton is sold in normal times to European manufacturers. The big importers of it are, according to the figures of 1913, England over four

million, Germany two and a half million, France one and a half million, Japan nearly two million, Austria, Italy and Russia nearly one million apiece, and Belgium, Spain, and the Netherlands about one-half million each.*

There are no figures available relative to the world production of cotton for 1920, nor for the world movement of cotton. The most recent statistics on the cotton situation in the United States shows that on December 1, this year there had been ginned 10,144,000 bales as against 8,344,000 bales for last year on the same date. The Bureau of Markets Service Bulletin of the U. S. Department of Agriculture for December 27, gives the movement of cotton in the United States as follows:

| *This week* 1920 | *Bales* |
|---|---|
| Visible supply | 2,778,000 |
| In sight for the season | 5,607,000 |
| Port receipts for the season | 3,304,000 |
| Overland to mills in Canada this season | 323,000 |
| Southern mills takings for this season | 1,329,000 |
| Northern spinners' takings for the season, including Canada | 555,000 |

| *This week* 1919 | *Bales* |
|---|---|
| Visible supply | 2,722,000 |
| In sight for the season | 7,015,000 |
| Port receipts for the season | 3,677,000 |
| Overland to mills in Canada this season | 759,000 |
| Southern mills takings for this season | 2,155,000 |
| Northern spinners' takings for the season, including Canada | 1,363,000 |

The most striking fact brought out by the above figures is the tremendous falling off of the amount of cotton being manufactured on this side of the Atlantic. The following clipping from the *Dallas News* suggests the explanation: "McKinney, Texas, Nov. 18.—Announcement was made here yesterday that the Texas Cotton Mill Company will close here temporarily Friday, according to J. A. Rountree, general manager. Lack of demand for the products of his mill was given as the reason. The mill, he said, now has on hand about $350,000.00 worth of goods for which they have found no demand. About 250 people are employed by the mill."

The devastations of the World War were the least in the cotton producing countries and most in the cotton buying countries. High prices due to inflation and other causes have tended to keep up the supply in the producing countries, while Japan is the only great buyer of export cotton in a position to take her normal supply without special credits. These war-torn countries are not only in need of credit to buy the necessary raw material, but their mills must be repaired and equipped and their labor forces very largely reorganized.

Most farmers planted and worked cotton this year on the basis of an anticipated price of 40 cents. All expected more or less deflation, but few expected it to come so suddenly and with such force. At the time the crop was projected the public was still in a buying frenzy. It almost seemed that the higher the price of an article the more readily it sold. When the public began to economize so vigorously, the manufacturers

*U. S. Department of Agriculture Yearbook, 1914.

and other middle-men were almost stampeded. They began immediately to cut down their output, in some cases to stop the factories. This cessation on their part has worked to their advantage greatly. It has cut off the supply of manufactured goods which will enable them to dispose of their product on hand at advantageous prices. They virtually destroyed the market for raw cotton and wool which will enable them to get their raw material at a low price. They have given their laborers such a scare that they have been able to reduce their wages as much as 20 per cent without serious trouble.

On top of all the above trouble, the financial condition is deplorable. Under conditions of uncertainty and falling prices banks are forced to call in loans to keep their reserves built up to the desired point of safety. It is all the worse in that it has come at a time when so much money is needed for moving the crops and live stock produced.

### A SOUND POLICY TO FOLLOW UNDER PRESENT CONDITIONS.

In the light of present economic developments what is the logical thing for farmers and ranchmen to do? There are many possibilities. The first impulse is to hold the present supply. In the case of non-perishable products like cotton and wool that is undoubtedly the logical thing to do, especially if the producers can devise means to control the future supply. There is no serious surplus of cotton and wool. The most serious fact is that the European market is exceedingly weak because the Europeans have neither the money nor the credit with which to buy. But if the producers are unable to control the supply next year, then those who hold this year, and hold the price up, may find themselves confronted with a worse situation next year, though such a condition would rarely occur, however, it is possible. Action here should be determined very largely by the efficiency of farmers organizations to control their own action.

The producers may take steps to immediately cut down their costs. They may organize and sell cooperatively and save thereby the expense of some middle-men. In some cases they may prevent excessive costs of harvesting and ginning by properly organizing. They may demand cheaper rates of interest and organize to get money at wholesale prices to be used in their productive processes, instead of getting it, if at all, at very high retail prices. A great deal may be saved through improved methods of buying.

Under conditions like the present, the best thing, the thing most needed is a system of strong farmers' organizations able to protect the interest of the members, whether it be an organization of cotton growers, wool growers, milk producers, or what not. In the absence of such business organizations among farmers and ranchmen the chances are their problems will periodically become more harassing.

However, the present situation may be materially improved by bankers and other business men lending their organized support to farmers and ranchmen that are temporarily in distress. The other important alternative is to use some means to stimulate the demand side of the market. The most important thing that may be done immediately is to devise a way to finance the people, in Europe especially, who want to buy.

What to produce and how much to produce are problems that must

be weighed very carefully by farmers and ranchmen in projecting their plans for the coming year. All indications point toward lower costs, especially of labor. Machinery and other tools have not declined appreciably yet, and unless they do the farmers and ranchmen will buy just enough to prevent the crippling of their operations.

It will not be wise for the farmers to quit any one crop entirely as a rule, and go entirely into any other one crop, as some are doubtless inclined to do. Some small grain on most farms, yes, but certainly all small grain on only a few. All cotton is equally as bad. If a man has his own labor supply, and is in a good cotton region, he may very well make cotton his principal crop; but this man should take every precaution to cut expenses to the minimum, both by planning to do his own labor and by living at home as completely as possible. The best policy for most farmers now is to plan to have as many varieties of products to sell as possible. Under the unsettled conditions, such a plan means double security. It is an insurance against complete failure due to bad crops, on the one hand, and on the other it insures against loss due to the excessively low price that may prevail in any one crop.

The successful farmer will not let present conditions modify his plans seriously. He will reduce costs to a minimum, but he will not forget that a good farm organization cannot be built in a day or a year.

On the whole the production end of the ranchman's business is more easily planned than that of the farmer's because his alternatives are fewer. No wise ranchman will quit sheep and goats because the price of wool and mohair is low, or cattle because beef is below the cost of production. To shift from ranching is impossible for many obvious reasons, but the ranchman may and should shift from a purely cow ranch to diversified ranching. It is the only way to get the best utilization of land, labor, and capital. A combination of cattle and sheep, or cattle, sheep, and goats, if possible, accomplishes the same purposes in a ranch country as crop rotation and diversification in a farming region.

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# TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

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DIVISION OF ANIMAL INDUSTRY

# THE SCREW WORM AND THE WOOL MAGGOT

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CIRCULAR NO. 27. APRIL, 1921.

# THE SCREW WORM AND THE WOOL MAGGOT

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No doubt almost every ranchman in Texas is only too well acquainted with the screw worm and the fly which produces it.*

This fly is a native of America, occurring from South America northward into Canada. Much trouble is caused by this pest in Panama, Mexico, Texas, Louisiana, Oklahoma, New Mexico, Arizona, and southern California. It has been frequently found in the other States, but not in such enormous and injurious numbers as in the warmer sections of the country. It is not so important east of the Mississippi river, outbreaks occurring only at long intervals.

The fly does not seem to have a very fixed range in altitude, temperature and humidity being the principal governing factors. It is most injurious at altitudes from sea-level upward to three or five thousand feet, although it will occasionally develop very rapidly at higher altitudes. The senior author at one time obtained fifteen fully developed screw worms from a man's ear at an altitude of 10,000 feet in Colorado. The yearly damage due to this pest in this country is quite variable, but it is conservatively estimated at $4,000,000.00.

## LIFE OF SCREW WORM FLY.

This insect, like all flies, passes through four stages of development, namely, the egg, larva (maggot), pupa (resting stage), and adult or fly stage. A small fly is not a young fly, but a fully grown or developed insect, the size depending upon the kind of fly and the amount of food obtained by the maggot which produced it.

*The Egg:* The eggs, which are elongate and white or creamy in color, are laid on carcasses of all kinds and in wounds. Fresh carcasses are preferred to old ones; however, old wool, or hair or mohair that is very dry and has lain upon the ground for weeks or months is often blown full of eggs after warm rains that cause the mass to produce an odor. The eggs hatch within 3 to 48 hours after they have been deposited, the length of time depending upon weather conditions and

*Known scientifically as Chrysomya macellaria Fabricius.

Figure 1. Eggs of screw worm fly on dead animal, the principal breeding ground of the screw worm fly.

other environmental influences. Eggs usually hatch sooner in and about wounds than on carcasses.

*Screw Worm or Maggot Stage:* As soon as the eggs hatch the tiny maggots are very hungry and are soon in mischief. If the weather is warm and favorable the maggots will be fully grown within three to four days. Under less favorable conditions six or more days may be required.

Figure 2. Screw worm greatly enlarged, side view.

*Resting Stage:* After the maggots are fully developed they migrate from the wound or carcass and work their way into the soil to a depth

of one to four inches. Here the maggot transforms into the pupa or resting stage. The change from the maggot to the fly takes place within three to fourteen days and sometimes longer when weather conditions are unfavorable.

*Fly Stage:* The adult fly immediately after emerging is quite pale, its wings are not developed, and it appears larger than it really is; but

Figure 3. Screw worm fly, side view. There are three dark stripes on the back.

after it has been exposed to the air for a few hours, the skin soon hardens, the bluish-green color comes out, there are three dark or black stripes on the back, and the front of the head assumes a red or yellowish appearance; hence the name "red heads."

It is at this stage that the fly is capable of feeding upon liquids from flowers and on blood and secretions from wounds or carcasses. After a few hours of rest the fly starts in search of food and a few days later is ready to begin laying eggs. Each fly may deposit as many as eight batches of 40 to 250 eggs. These are laid during a period of a week or more and a total of 1,000 or more may be deposited. On carcasses one will often see a mass of eggs half as large as a man's fist where many screw worm flies have been depositing.

## MIGRATION OF FLIES.

The screw worm fly, like many birds, seems to have the migrating instinct and even passes over suitable breeding ground in its travels. This is one provision of nature whereby the species may spread and enlarge its realm of activity. Experiments carried out with marked flies by Bishopp and Laake absolutely prove that the screw worm fly will and does travel at least fifteen miles. It was also shown that the fly does not necessarily travel with the wind. In fact, this pest when seeking a place to deposit its eggs will usually travel against the wind, following a scent for a considerable distance.

The screw worm is essentially a warm-weather species. Several days of warm weather, with the maximum temperature reaching about 80° F. and the nights being not too cool, are required before egg-laying begins. Usually very few cases of screw worms occur in living animals until one

or more generations of the worms are bred out in carcasses and the flies become fairly abundant. The time when the cases of screw worms begin to occur depends upon seasonal conditions and latitude. Usually few cases occur before the early part of May and maggots found in old wounds and in the wool on sheep earlier than this are the young of the black blow fly, which withstands low temperatures and is very abundant in April and May. The black blow fly decreases with the coming of warm weather and may disappear entirely in midsummer. The screw worm fly usually increases during June and then its numbers often suddenly drop on account of climatic influences. When very hot and dry weather prevails in August the screw worm flies almost completely disappear although there may be some local outbreaks due to local causes. About the latter part of August to the fifth of October, 1920, there was an enormous swell or outbreak of the flies accompanied by heavy and warm rains with intermittent short periods of sunshine and warm weather. From October 5 on there was a general decrease in the number of screw worm flies present until all of them had disappeared by about the middle of December. Warm showery weather favors their multiplication. The warm temperatures hasten the development of all the stages and the rains keep carcasses and wounds moist and attractive.

Investigations carried out by Mr. D. C. Parman of the United States Bureau of Entomology at Uvalde, Texas, show that while the barometer is falling just before a large storm the flies are very active, but that later they fall into a stage of coma or inactivity. It is while in this state that large numbers are destroyed by many agencies. Then about fifteen days later there is another rather sudden outbreak of the flies due apparently to the emergence of the immature stages.

## CONTROL MEASURES.

*Sanitation:* Sanitation even on a ranch cannot be overemphasized. Poor sanitation is the root of much evil. Only too often one may see rubbish scattered everywhere, a dead chicken here, a dead cat there, one or more carcasses of sheep, goats, or cattle lying about the ranch headquarters or on the range. As each carcass breeds myriads of flies, such practices simply encourage outbreaks among the live stock. If an infectious disease is present the germs causing it become rampant in the water and the soil, or may be carried from place to place by certain insects. Why not clean up and keep clean? It is easier to keep clean than it is to clean up. Why not burn all dead animals and trash? Fire destroys all maggots, carcasses and disease germs with which they are infected.

*Carcass Burning:* To completely burn a carcass is not a difficult matter. When one realizes that a carcass of a horse or cow may breed out 1,000,000 or more screw worm flies or may be the means of infesting the premises with charbon (anthrax) the importance of destroying carcasses immediately and completely is evident.

It matters not how a carcass is burned, just so it is completely consumed. Where charbon or black leg is suspected it is best not to move

the carcass. The main and important idea is to have the fire beneath the animal. Wood piled on top of an animal may burn and char part but still allow hundreds of thousands of screw worms to develop. The simplest way is to place the carcass on top of a pile of wood. If the carcass is that of a goat or a sheep, it may be placed on top of a sotol or sachauista plant with the addition of some extra fuel. The trench method is the most satisfactory where digging is possible. Dig a trench along the back of the carcass nearly as wide as the animal and as long, and 12 to 14 inches deep. Then fill the trench with wood, using, if possible, several large pieces and roll the animal onto the pile. About one-quarter of a cord of wood is sufficient for a cow or horse. Start a fire at the windward end and the entire carcass will be completely consumed within twelve to twenty-four hours. It is always best to return

Figure 4. Trench to be filled with wood or cow chips for burning carcass.

to the burning a few hours later so as to place the feet and head over the fire.

In many sections of the State there is no wood close at hand; hence other methods must be resorted to. If cow chips are at all numerous they make fairly satisfactory fuel in the trench method.

*Buzzards and Screw Worms:* What shall we do with the buzzards, crows, and other scavengers? Some ranchmen protect them while others destroy them. While they destroy much refuse they are undoubtedly active agents in the spread of diseases such as anthrax and black leg. They are known to attack weak animals. Although they serve the purposes of aiding the stockman to locate carcasses they cannot be depended upon to destroy them completely enough to prevent screw

worm breeding. Even though a carcass is practically stripped by buzzards, the remains should be gathered up and burned to prevent the breeding of flies.

*Poisoning:* Poisoning was one of the earliest methods resorted to in the attempt to reduce the number of flies. During 1912 to 1916 numerous tests of poisoned baits were made by agents of the Bureau of Entomology. Meat, blood, and various mixtures were tried with different poisons, but none was found which remained attractive very long. Most poisons, and especially arsenic and formaldehyde, have a tendency to preserve animal matter and reduce the odor given off. In New South

Figure 5. Carcass on wood (1-4 cord) in trench ready for burning. In this way an animal is consumed without the addition of fuel

Wales (Australia Farmers' Bulletin No. 95, p. 14, 1915), mention is made by partly skinning the carcass, slashing the exposed flesh and then treating one-half of the carcass with a solution of one pound white arsenic dissolved in five gallons of boiling water. It is stated that for a short time thousands of the flies are killed. A modification of the above method was used by Mr. Fred Earwood, Sonora, Texas, in 1919, before he knew about other work along this line. In 1920 cooperative work was carried on with Mr. Earwood. Several methods of poisoning were tested. The most successful and satisfactory method found was to kill a goat or a sheep, skin it, partly gut it, and suspend it from a limb

of a tree so that the head, neck, and shoulders would remain in the tub containing the poisoned mixture of, say, about four liquid ounces of Buenos Aires hide poison (sodium arsenite) or one to one and one-half gallons of arsenical dip mixed with seven to ten gallons of water. The screw worm and blow flies are freely attracted by the odor and most of them sip some of the poison before leaving. It was found that large numbers of the flies can be killed in this way; however, the bait usually will not remain attractive longer than a week or ten days. It is then best to burn the remains and supply a new carcass.

Poisoned baits should be placed out of the reach of stock and away from poultry, as chickens may be killed by eating the poisoned flies.

*Trapping:* Within recent years fly trapping has been quite popular. As a result, many different kinds of traps have been devised and patented. However, in most cases no careful study has been made to develop a trap best suited for the different species of flies concerned. Careful experiments along this line were carried on by Bishopp and Laake with the result that a general purpose trap has been devised which when given the proper attention will give excellent results.

This trap is shaped as a cylinder and is 24 inches high and 18 inches in diameter with a screened top and a cone 22 inches high. The diameter of the cone is 18 inches at the base and 1½ inches at the opening in the top. Legs are 1 to 1¼ inches high and so constructed that the trap can be securely fastened to a platform. A metal frame is by far the best, as the danger of flies escaping through cracks is reduced. It is advisable to empty the trap once a week, especially during the height of the fly season.

*Locating and Setting a Trap:* The proper location and baiting of a fly trap is an essential feature in ranch management. In general, the flies seem to be more numerous along streams, water holes, draws, etc.; hence the advisability of placing traps somewhere near the principal water holes, about "wormy traps,"* and the headquarters. If the traps are placed on platforms about 20 inches square and four to five feet above the ground, preferably in partly shaded situations, there will not be much danger of molestation from stock or wild animals. Each leg of the trap should be fastened to the platform. If a metal leg, it may be bent over and an oblong hole punched in the leg to receive a screw eye, which when turned one-fourth way will securely hold the trap to the platform.

*A "wormy trap" is a small enclosure containing ten or more acres in which screw-worm-infested animals are placed during the period of treatment.

Figure 6. Fly trap on platform in tree in "Worm Trap"

"Where may these traps be obtained?" is a question often asked. There is no patent on the described trap. They may be made with lath, screen wire and barrel hoops or they may now be purchased from the Crowther Hardware Company of San Angelo or the Junction Hardware Company, Junction, Texas, or through several of the hardware stores in west Texas. The metal traps are now made in knock-down form and crated for shipment.

A good bait pan is also advisable. Any pan may be used, but for best results a pan 14 inches in diameter with vertical sides 1½ inches deep will give best results. The bait may be varied according to the kind of good cheap bait at hand. Jack rabbits cut open and placed in the pan make an excellent bait. Where available large rattlesnakes probably make the best bait of all. Meat of any kind makes good bait, and it will last three to five days. The entrails of animals with the fat removed are good, but the paunch is very poor bait. Water added to the bait pan will increase the attractiveness, especially if the bait is stirred occasionally.

Last year Armour & Company of Fort Worth, following the suggestions of the Bureau of Entomology, prepared a dried bait known as

"dried gut slime." The material in the undried state is a most powerful blow fly attractant. The dried product is very promising, but the details of manufacture and use have not been fully worked out. It has the advantage of being highly concentrated and therefore easily carried when one is riding the range. It is also much less likely to breed maggots if neglected a few days than the meat baits. About six ounces of the bait are stirred in the pan with two quarts of water. This will last about a week, but it is necessary in hot weather to add water and stir the bait every two or three days.

To empty a fly trap, invert the trap, jar down the dead flies, remove the lid, and dump the flies; then place the lid back on and right the trap. Very few living flies will escape in the operation. A fly in a trap will live one to three days in warm weather. The dead flies may be scattered broadcast without harm or they may be fed to the chickens with good results.

Trapping or poisoning should not be depended upon alone to control the screw worm. If systematic destruction of carcasses is not practiced flies will breed much faster than they can be killed.

Complete destruction or eradication of the screw worm cannot be hoped for, but by concerted effort the pest can be reduced so that its activity will be negligible. It is undoubtedly better to prevent screw worm attack than to occupy even the same amount of time in treating infested animals. Many ranchmen have proved to their own satisfaction that by promptly burning every carcass found and by giving proper attention to a number of fly traps, especially around the "wormy or hospital traps," they have very materially reduced the number of screw worm cases on their ranches.

*Screw Worm Cases, Prevention and Treatment:* As is well known, screw worm flies will deposit eggs in or on any kind of wound and after the "worms" once get started the odor increases, more flies are attracted, more eggs laid, and the wound grows larger until finally the animal succumbs. This means that it is of the utmost importance to avoid the production of wounds and raw sores. Wounds are produced in many ways, but only a few will be mentioned. Among sheep and goats shear cuts probably occupy first place. When flies are abundant, one usually expects a worm case for every shear cut unless some good means of prevention is taken. Other causes of wounds are barbed wire, thorns on wild plants, crushed ticks, and ear ticks, sores following horn-fly injuries, dehorning, calving, lambing and kidding at the wrong season of the year, and horn injuries resulting from hooking and fighting.

Figure 7. Exposed scull on top of sheep's head due to screw worms.

In 1917, Mr. D. C. Parman of the Bureau of Entomology began experimenting with various chemicals as fly repellents. It soon became apparent that nearly all flies were driven off by the camphors. One of the mixtures developed has been used with satisfaction by a number of stockmen. Mr. E. E. Stricklen of Juno, Texas, reports excellent results in protecting wounds from worms by using a mixture consisting of two ounces of gum camphor dissolved in one pint of heated machine oil.

At Substation No. 14 nineteen different compounds have been tried out with the result that a few are giving promising results. As some ranchmen prefer liquids to powders and others the contrary, the most promising formulae of both are given. For actual use in all of these mixtures except the Parman formula it is presupposed that the maggots are first killed with the stock chloroform and then removed from the wound before the repellents and healing agents are applied. When a powder is applied the wound will scab over better if the repellent can be forcibly blown into the wound with a blow gun or dusted on with a pepper shaker and firmly pressed into and against the wound.

The most promising repellents are as follows:

All Parts by Weight.

*Powders.*

| | |
|---|---|
| Powdered alum | 80 parts |
| Zinc oxide | 60 parts |
| Boric acid (powdered) | 30 parts |
| Gum camphor | 6 parts |

Cost per pound, 47 cents.*

*Based on wholesale prices of May, 1920.

| | |
|---|---|
| Gum camphor | 5 parts |
| Powdered charcoal | 100 parts |
| Laundry starch (powdered) | 50 parts |
| Boric acid (powdered) | 10 parts |
| Tannic acid | 10 parts |

Cost per pound, 42 cents.*

*Liquids.*

| | |
|---|---|
| Pine tar | 1 quart |
| Machine oil | 1 quart |

and

| | |
|---|---|
| Chloroform U. S. P | 1 pound |
| Gum camphor | 4 ounces |

Cost per pound, 40 cents.*

Keep the chloroform mixture in amber-colored bottles. For use, mix one part of the chloroform mixture with four parts of the oil mixture. Mix at time of using, as the mixture will not keep over two to three days. This mixture is known as the Parman formula.

| | |
|---|---|
| Pine tar | 4 ounces |
| Castor oil | 6 ounces |
| Kerosene oil | 10 ounces |
| Turpentine | 1 ounce |

Cost per pound, 14 cents.*

| | |
|---|---|
| Pine tar | 20 ounces |
| Glycerine | 10 ounces |
| Turpentine | 1 ounce |

Cost per pound, 7 cents.*

Occasionally there are wounds that require special treatment, as, for instance, the exposed skull of a sheep. Cotton and gauze should be placed over the skull to protect the animal from the heat of the sun. It is advisable to secure the services of a competent veterinarian for the treatment of extensive infestations in dangerous places, especially if the wormy animal is a valuable one.

It will pay any stockman to have a screened house to be used for all extremely bad wormy cases in their highly-bred stock. Many ranchmen have used such houses with excellent results.

## RANGE MANAGEMENT.

It is not the intention to discuss this question in detail, the object being merely to emphasize a few points that have their bearing on the screw worm question.

*Fencing:* The abolition of barb wire fences would do much toward reducing screw worm troubles and serious injuries. In some sections of the range country cattlemen are fencing with six- or seven-gauge,

*Based on wholesale prices of May, 1920.

spring-steel smooth wire. Many are still more advanced in that they use smooth wire netting in their wolf-proof fencing. By clinching nails, removing protruding objects, etc., one can do much to prevent injury and resulting infestations.

*Calving, Lambing, and Kidding:* Every year many young calves on the southwestern ranges become infested with screw worms at the naval. The same may sometimes be said of late lambs and kids. To reduce screw worm cases, it is advisable to have the offspring dropped some time during the inactive screw worm season. February, March, and April or the early part of May at the latest is the best time in west Texas. To carry out this program the provision of additional feed to supplement the range vegetation will be necessary during a dry year.

*Dehorning:* If dehorning of cattle were more extensively practiced on the southwestern ranges, the percentage of screw worm cases would be materially reduced. The cattle should be dehorned in December or January; however, this operation should not be performed on hot days, since the black blow flies are likely to be active, especially during the heat of the day. The percentage of screw worm cases among polled herds in west Texas has been much smaller than among horned herds; consequently this question should be given serious consideration by those stockmen of the southwest that have not made such a practice a rule.

*Overstocking:* Probably two of the greatest evils are overstocking and providing no feed reserve for dry years. Thousands of live stock die upon the open range during such years, thus affording the best breeding ground for the dreaded screw worm fly. The number of head to safely run per section on a ten-year average will vary greatly according to the location; hence each ranchman must work out his own individual maximum run per section.

### THE BLACK BLOW FLY OR WOOL MAGGOTT.*

This is the real wool-maggot fly of Texas. It is a little longer and usually a little broader than the screw worm fly. It is of a black or blackish-blue color, and smooth. The three black stripes on the back and the red head as we find in the screw worm fly are absent. With the advent of cold weather even during the latter part of August, it may appear, but usually it is hardly noticed until October. From that time on it increases in numbers throughout November. During cold weather it is not active, but quickly appears on warm days in January and February. On January 4 to 11, 1921, a third of a quart, or approximately 2700 flies were caught in a trap. Ninety-two per cent of these were the black blow or wool-maggot fly, while the remaining eight per cent consisted of several species of large winter blow flies, but no screw worm flies. Not only does this fly blow wool; it also is responsible for wormy cases in the heads of cattle that have been dehorned on warm days in midwinter or early spring. If, after dehorning, a dressing of

*Known scientifically as Phormia regina Meigen.

pine tar is applied to the wound or a good dusting powder used, the number of cases of worms should be greatly reduced.

The amount of trouble from blown wool depends much upon weather conditions. When warm rains or foggy weather prevails in spring the flies lay eggs in the wool, especially if soiled during lambing. During the spring, many of the cases of worms around the base of the horns of bucks are produced by this fly and are not screw worms. The black blow fly is a carcass breeder: hence its multiplication is prevented by burning carcasses. Traps operated as described for screw worms will also reduce the numbers of this fly.

ACKNOWLEDGMENT.

The Station is indebted to the Sheep and Goat Raisers' Magazine, of San Angelo, Texas, for the loan of the cuts shown as Figures 1, 3, 4, 5, 6, and 7, in this Circular, and grateful acknowledgment is hereby made for this courtesy.

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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 28. APRIL, 1921

DIVISION OF VETERINARY SCIENCE

# INTERNAL PARASITES AFFECTING SHEEP AND GOATS

CAUSES, LIFE HISTORY, SYMPTOMS, AND TREATMENTS

B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

CIRCULAR NO. 28. APRIL, 1921

# INTERNAL PARASITES AFFECTING SHEEP AND GOATS

## CAUSES, LIFE HISTORY, SYMPTOMS, AND TREATMENTS

By D. H. Bennett, V. M. D., Veterinarian.

The Internal Parasites most commonly affecting sheep and goats in southwest Texas are as follows: Grub in the Head or Sheep Bot (Larval form of the Oestrus ovis or Sheep Gad Fly); Lung Worms (Synthetocaulus rufescens and Dictyocaulus filaria); Stomach Worms (Haemonchus contortus); Liver Flukes (Faciola hepatica); Tape Worms (Moniezia expansa and Thysanosoma actinioides); Nodular Disease (Oesophagostomum columbianum); Whip or Caecal Worms (Trichuris ovis).

## GRUB IN THE HEAD.

This parasite is caused by a mottled grey fly laying one or more larvae in the nostrils of sheep and goats. This fly is about the size of a bee and is termed Oestrus ovis. The greatest infestation usually occurs during the hot periods of the year, but infestation can also take place during the warm days of late fall, early spring, and winter.

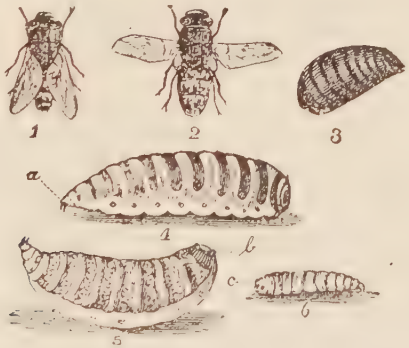


Figure 1. (Gad Fly.) Oestrus ovis: 1 and 2, adult fly; 3, pupa; 4, full-grown larva, dorsel view; 5, same, ventral view; 6, young larva. 1 and 2 natural size, the others enlarged. (After Underhill.)

The presence of the fly is shown by the attitude of the animals, especially of sheep. They will stand huddled together in the shade, protecting their noses as much as possible by holding them under other sheep or down in the grass. When a fly attacks them they hold their noses to the ground, stamp their feet, snort, rub their noses on the ground, or legs, and finally run for no visible cause.

## Symptoms.

Probably the most pronounced symptoms are seen during the first stages of infestation when the larvae are working their way, by means of hooklets and spines, to the upper air passages of the head and horns. The favorable locations are the air passages or sinuses situated between the eyes and above the grinder (molar) teeth of the upper jaw in hornless animals, while in horned animals they seek the same places and in addition the air cavities of the horns.

The larvae, after having been deposited in the nostrils, ascend the nasal air passages causing the animal to rub it nose on the ground, snort, and show great uneasiness. During this time a mucous nasal discharge manifests itself, varying in degree as to the infestation present and the temperament of the animal. At times long shreds of mucous, sometimes mixed with blood, may be seen hanging from the nose. This stage generally takes place in the summer or early fall causing labored breathing, uneasiness, and loss of condition. In about six to eight weeks the larvae become located after which time the secretion will decrease somewhat.

When the Grub or Bot becomes located it will shed its skin or moult several times, growing larger each time until matured. It lives on the secretion of the mucous membranes lining the air passages, into which it has worked its way. When it has matured, it is about three-fourths to one and one-fourth inches in length and about one-fourth of an inch in diameter and banded with stripes of dark brown and white. At this stage it descends the nasal cavities to the nostrils and thence to the ground into which it buries itself, appearing later as a fly. During the descent of a number of grubs practically the same symptoms will be seen as during the invasion of the small larvae.

## Treatment.

No safe remedy has been found as yet on account of the fact that a remedy sufficiently strong to kill the larvae would set up such a severe irritation of the mucous membranes that it would probably kill the animal, therefore prevention by the following method must be resorted to in order to keep these parasites in check.

A plank two inches thick is used, in which holes about two to three inches in diameter are bored at intervals of 18 to 24 inches. These holes are tapered from top to bottom, the top being about four and one-half inches in diameter. This is placed over the top of the salt trough and the salt in the trough should be kept at such a level that it will be necessary for the animal's nose to touch or rub the edges of the hole when it is licking the salt. The entire surface of these holes is smeared once every three days with white pine tar and oil of eucalyptus, two ounces of the latter being added and well stirred to each pint of tar immediately before using. This mixture is smeared on the nose of the animal while licking salt and if the Oestrus ovis should deposit larvae in this they will usually die. Probably a more efficient method would be to smear the above mixture on the nose and adjacent parts with a brush. A new application should be made at least every week or ten days. The latter method is practical only for young animals or registered stock.

## LUNG WORMS OR VERMINOUS BRONCHITIS.

This disease is caused by the invasion of the lungs by small thread-like worms which infest the ends of the small air passages (bronchioles and alveoli or air sacs). When mature these worms average about one to three inches in length and are reddish-white in color. This worm is termed Synthetocaulus rufescens. There is also a smaller worm, comparatively rare, termed Dictyocaulus filaria which produces slightly different lesions.

Figure 2. (Lung Worms.) Synthetocaulus rufescens; male at right, female at left. Natural size. (After Underhill.)

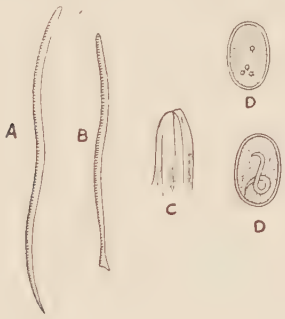


Figure 3. (Lung Worms.) Dictyocaulus filaria: a, female; b, male, natural size; c, anterior extremity; d, eggs, enlarged. (After Underhill.)

It is believed by most men who have studied the life history of this worm that the entire life cycle is passed within a broken-down area of the lungs. However this has not been definitely proven, as is true also of the manner in which the infestation takes place.

### Symptoms.

Some time passes after infestation has taken place before symptoms will manifest themselves. The usual symptoms are labored breathing with occasional coughing of more or less violence, lack of condition, and a wheezing or rattling noise which can be heard when the ear is pressed to the chest. Owing to the weakened condition of the animal other parasites may invade other parts of the body thus hastening its death. It is usually a disease of long duration, fatal only after months and years, sometimes several years elapsing before the animal dies. In

animals which have died from this condition there will be found various-sized elevated areas on the surface and within the lungs which are green or greenish-yellow in color. These areas when cut open immediately after death will be found to be filled with pus and worms of varying sizes. All dead animals should be burned to prevent other animals from becoming infested. It has seldom been seen among the native, range-raised animals of southwest Texas, but has been found in several animals brought into that part of the State from other localities.

### Treatment.

In the advanced stages of this condition treatment is of no avail because of the inaccessible location of the worms. In the early stages good results have been had from the use of one-half teaspoonful of chloroform (anesthesia). One may pour the chloroform into the nostril or inject it slowly between the rings of the windpipe (trachea), using a hypodermic syringe with a short needle, injecting the chloroform slowly into the trachea. When the chloroform is given through the nostrils, the head should be held high so the chloroform will reach the trachea. With either method the above treatment should be repeated on three consecutive days.

## STOMACH WORMS.

About two years ago in scattered sections of the southwestern part of the State, lambs and kids became thin and soon died from no apparent cause to the owners. These losses have increased and spread until virtually all sections where sheep are raised have had losses of a similar nature.

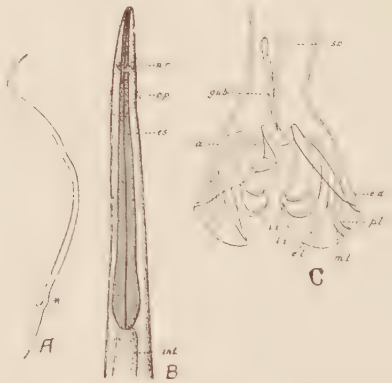


Figure 4. (Stomach Worms.) A, Haemonchus contortus, female, vulva x5; B, Haemonchus contortus, anterior portion of body, enlarged: C, Haemonchus contortus, posterior extremity of male, dorsal view, enlarged. (After Underhill.)

There was one reason for these losses, it being stomach worms. Favorable weather and range conditions along with the high price of wool and mohair induced ranchmen to increase their flocks to the maximum and sometimes they overstocked. Drought conditions in several northern sheep-raising states caused thousands of sheep to be

shipped to Texas and ultimately sold and placed on the range, no precautions being taken except against sheep scab. Without a doubt the conjested ranges along with other unfavorable conditions were instrumental in the spread of stomach worms.

## Cause.

Animals, especially young, pastured over an infested area pick up the eggs and larvae of the stomach worms with their feed and from stagnant waterholes. They are swallowed along with the food and fasten themselves to the mucous lining of the fourth or last stomach. When performing a post-morten examination on an animal, one can most easily locate the fourth stomach if he will lay the animal with its left side to the ground. The hide and front leg are laid back and the hind leg is disjointed at the pelvic joint. Next, a cut is made directly back of the breastbone over the sternal cartilage and carried back to the middle of the pelvis, then up to the backbone. Another cut is made along the edge of the last rib from the sternal cartilage to the backbone or spine. This flap is laid back exposing the entire right side of the viscera. The liver and a portion of the gall bladder will be seen directly back of the last rib. Below the gall bladder will be seen a striated or striped sac-like pouch with its enlarged portion just under the sternal cartilage, tapering as it extends to join the small intestines just below a point where they make an S-curve. This is the fourth stomach. When it is opened, if stomach worms are present, there will be seen twisted, small hair-like, reddish-brown worms, some fastened to the mucous lining, other free in the stomach contents. The worms average three-fourths to one and one-half inches in length. Here they mature, mate, and lay eggs, which pass from the animal's body to the ground.

The eggs will hatch into tiny worms within 12 to 36 hours, the time depending upon weather conditions. The weather being favorable, these larval worms will crawl up the stems of the wet grass, moult, and finally become encysted. The larval worms while in this condition may live for months. They are able to withstand severe extremes of heat, cold, and drought.

When an animal that is in the normal state of health is opened the blood will be a dark red and will coagulate quickly. But in an animal suffering from almost any internal parasite, especially the stomach worm, the blood usually will be thin and pink, and will coagulate only after standing some time.

## Symptoms.

At the beginning of the infestation no pronounced changes will be noticed but after several months, dullness, slight diarrhea, and falling-off in flesh may manifest themselves. The infested animals will stand by themselves and will not eat, but drink quite frequently. Sometimes swellings appear under the lower jaw. The hair coat becomes dry and harsh and lacks lustre. The skin of normal animals is pink, while that of animals with stomach worms is white and dry, and lacks flexibility. The mucous linings of the eyes, nose, and mouth become grayish-white; the eyes sink in their sockets, and pronounced emaciation and weakness ensue followed by death.

## Treatment.

Up to the present time, the copper sulphate or blue stone treatment far excels all others. It is cheap, easy to administer, and reliable when used correctly. The best policy if a ranchman has stomach worms in his flock is to dose the entire flock and then move them to a new pasture.

For every 90 grown sheep or goats, or 180 lambs or kids under 9 months of age, one-fourth pound of clear copper sulphate crystals should be dissolved in one pint of boiling water. An agateware, glass or wooden vessel should at all times be used for mixing the entire solution, as metal vessels decompose the solution rendering it valueless. When the crystals are entirely dissolved, enough cold water to make three gallons of solution should be added and the mixture thoroughly stirred.

It has been noticed that the water in certain sections of this country will not make a clear blue solution. Sometimes it is milky and then again a precipitate will form in the bottom of the vessel. To remedy this fault a two-ounce bottle of sulphuric acid should be obtained and added drop by drop to the solution being continuously stirred, until the solution becomes clear blue. Care should be taken that just enough acid is used as an excess will prove harmful.

*Caution:* When not in use the bottle of sulphuric acid should be kept in a place where it will not be broken, and away from children and animals as it is a violent poison internally and also will make severe burns on the skin externally.

The best results are obtained when the animals to be dosed have been deprived of feed and water overnight. When thirsty they will take the solution more readily and the stomach will be more or less empty, thereby permitting the solution to come into direct contact with the worms. After having been dosed, feed and water should be withheld from the animals for six hours in order that the solution will not be diluted until it has fulfilled its purpose.

Young lambs or kids should receive two ounces of the above solution while those over 9 months of age should receive four ounces. The dose should be given in the following manner: One or preferably two two-ounce hard rubber rectal syringes with a tip at least two or three inches long should be procured. The animal should be held securely with its head parallel to the ground. The tip of the syringe should be slipped between the cheek and the molar or grinder teeth and the plunger pressed slowly. Haste is to be avoided at all times. If the animal should choke, it should be given its head at once. At no time should the dosage be exceeded or diminished.

In flocks where the infestation is severe, best results may be had by treating again in ten days and then every two months for at least a year. Pastures should be changed after each treatment, allowing each pasture to rest, if possible, for six or eight months. The latter practice is recommended because of the fact that once a pasture is infested, it will remain so for as long as a year, provided weather conditions are favorable. The writer does not believe that it is possible to completely eradicate stomach worms, but to keep them in check is possible if the work is carried on systematically.

Another treatment which has proven of value when given in con-

junction with the blue stone solution, is as follows: Mix thoroughly 2 pounds of powdered blue stone and 1 pound of powdered copperas or iron sulphate to every 100 pounds of salt and keep before the animals. After a period of three months the copperas should be left out of the mixture, because when given over a longer period of time, loosening of the teeth may develop due to the receding of the gums. The iron is beneficial for the reason that it restores the oxygen carrying properties, causing blood to become red again.

### Prevention.

All animals should be watered from troughs which should be cleaned often.

All newly purchased animals should be isolated and given two treatments for stomach worms and later treated for tape worms before they are allowed to mix with the other live stock. It is well to isolate any animal for two weeks or a month before giving freedom of the range. Serious outbreaks of disease have been caused because this precaution was not taken. All ranches should have a small pasture fenced off convenient to water, preferably at the entrance to the ranch for this purpose.

If the pastures are small and well located as to ranch headquarters and water, and the stock are changed from pasture to pasture at least every two months, not only will the general health of the animals be improved but also the condition of the pastures. Where disease or parasites are present in a pasture where large numbers of animals are pastured together over the same range for a long period of time, these animals will be subject to heavy losses from these causes, especially if of a contagious nature.

## LIVER FLUKE.

A disease known as liver rot has made its appearance from time to time in sections of this State, chiefly in locations where animals have access to pasturage on river bottom, overflowed, or low, flat, poorly drained land. It attacks animals having four stomachs (ruminants) more often than those having but one stomach; however, the latter have been attacked in several instances.

Sheep and goats are of the former class and old and young alike may become heavily infested, though sheep are more often affected with this trouble because they graze more closely to the ground than most animals.

### Cause.

Liver rot is due to a flat, pale-brown, somewhat triangular-shaped parasite which infests the bile ducts of the liver and lives on the blood and waste products produced by its presence. Animals become infested after having swallowed with their food and water certain forms which resemble miniature flukes. An embryo fluke develops from an egg passed by an infested animal; after having hatched, and having gone through a change in form in the intermediate host (the water snail of certain species), and freed itself from this host, it becomes encysted on the wet ground or grass. If eaten by an animal, it passes into the first part of the small intestines. Here it seeks the bile duct, which opens

into the small intestines six or eight inches from the fourth stomach, passes up this main bile duct and thence to the small bile ducts. Here it sets up an irritation which leads to the following symptoms.

## Symptoms.

A short time after the parasite has reached the upper bile ducts, the infested animal's condition improves rapidly, on account of the increased flow of bile. During this period of migration up the bile ducts, the fluke becomes so large that it may partly or entirely close them. This migratory period usually takes from one to three months. The animal, still with a good appetite, becomes listless. The mucous membranes of the eyes, nose, and mouth become yellowish-white, and slight swellings around the eyes, lower jaw, and abdomen are sometimes manifested. At times the abdomen may become greatly distended on account

Figure 5. Life Histo;y of Liver Fluke; 1, egg containing developing embryo; 2, free swimming mira-idium; 3, sporocyst, 3a, snail of the genus Limnaea; 4, division of sporocyst; 5, sporocyst containing developing rediae; 6, rediae with cercariae or more rediae developing within it; 7, cercaria; 8, young fluke. (After Underhill.)

of ascites or water around the viscera. The animal gradually becomes weakened and emaciated. Other conditions may develop such as diarrhea, excessive waterly swellings of the eyes, abdomen, and lower jaw. Yellow (icteric) coloration of all the visible mucous membranes follow in a shrt time due to the blocking of the bile ducts of the liver, which causes the bile to be taken up by the blood and deposited in the tissues. At about this stage the flukes start to migrate down the bile ducts to the intestines and the animal may begin to show improvement. The flukes, having completed their life cycle in the liver, pass into the intestines and thence to the ground. This life cycle generally takes

nine to fifteen months, though sometimes a longer period may elapse before it is completed. The best procedure when a number of animals become affected would be to kill several and examine the liver for swellings. These swellings when cut into, if due to liver flukes, will reveal pale-brown arrow-shaped parasites, segmented along the edges and from one to one and one-half inches long. The finding of the fluke is the only manner in which a positive diagnosis can be made, because the external symptoms closely resemble those of stomach worms.

### Treatment.

Probably the best treatment developed to date is the etherial extract of male fern. It is given for five or six consecutive days in one-dram doses combined with one ounce of linseed or cottonseed oil. This dose is sufficient for good-size lambs; grown sheep may receive one and one-half to two drams. The size of the dose depends on the condition of the animal and must be combined with oil in correspondingly increased doses. (A teaspoon level full will hold approximately one dram; while a tablespoon level full will hold about one-half ounce). At the present time the above treatment is rather expensive, costing about 50 cents a dose, exclusive of oil and labor, but it is the only reliable treatment at the present time.

### Prevention.

Once a pasture becomes infested with liver fluke, it might as well be abandoned or put under cultivation, although it has been reported that five hundred pounds of salt well spread over each acre will kill the infestation by destroying the snail which is necessary for the development of the embryo fluke.

All animals dying from liver fluke should be immediately and completely burned.

## TAPE WORMS.

Several species of tape worms infest sheep and goats, but those most commonly found are Moniezia expansa and Thysanosoma actinioides. These, like the liver fluke, have occurred in scattered localities and invariably occur where sheep and goats have pastured on low or marshy land or have been brought from such a location to another ranch where the tape worms later develop, causing heavy losses, not only among these animals but also among the younger stock on the ranch.

The Moniezia expansa is the more common, the mature segments of which are broad and flat, while those of the Thysanosoma actinioides are smaller with the base fringed like the teeth of a saw. Both are found in the small intestines. The head, the smallest part of the worm, is attached to the intestinal walls by means of four sucker discs. The larger part of the worm is made up of the segments, which float free in the intestinal contents where they absorb their food, thus depriving the animal of considerable nourishment. These segments vary in number as to length of the worm from one to thirty feet. Next to the head, the segments are short and narrow, but become longer and wider as the worm grows in length. When mature each segment produces eggs which, after having dropped to the ground, are believed to live in

water or on the damp ground, later being picked up by an intermediate host.

The segments of tape worms are white and may be found in the droppings of the infested animals, but when found in this manner are distorted in shape. The entire life history has not, as yet, been worked out for all tape worms. It is known, however, that most tape worms spend a part of their life cycle in some intermediate host, either an animal or an insect. Such a state is termed the cystic form of the tape worm. In sheep and goats the cystic form of the tape worms of the dog, Taenia marginata, infests the covering of the liver and caul fat. The Taenia coenurus, also of the dog, infests the brain of the sheep. This cyst when well developed produces the condition known as gid, due to the pressure of the cyst on the brain.

Tape worms are more fatal to young animals, but are sometimes the

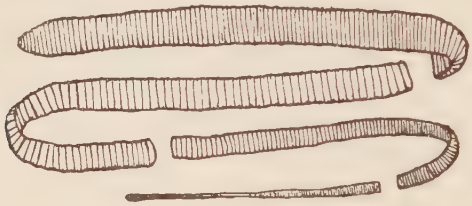

Figure 6. (Tape Worm.) Moniezia expansa: portions of adult reduced. (After Underhill.)

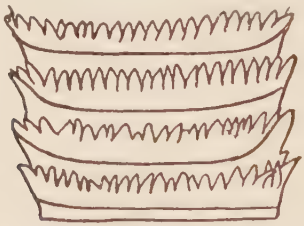

Figure 7. (Tape Worm.) Thysanosoma actinioides, anterior segments, enlarged. (After Underhill.)

cause of unthriftiness and losses among grown animals. Warm, moist weather, together with low, flat, poorly drained ground, is ideal in this development of tape worms. Spring, summer, and early fall in this State are the seasons during which most of the losses take place, although heavy losses have occurred during the winter when the animals have become emaciated and unable to withstand the rigors of cold weather.

The growth of a tape worm when in the animal body is very rapid, attaining a length of six feet or more in two months' time. Sometimes if the infestation be large in numbers a stoppage of the small intestines may occur, causing almost immediate death. Usually, however, death is due to the extreme emaciation caused by the worms absorbing most of the nutriment intended for the sustenance of the animal. Some writers believe the tape worm also secretes a poison which inhibits the assimulation of the food, producing a condition akin to starvation.

### Symptoms.

Segments are present in the manure, associated with diarrhea, which is caused by the movements of the worms irritating the intestinal mucous membranes. The diarrhea is also believed by some investigators to be due to a substance secreted by the worms which causes the intestinal contents to become more fluid and more easily assimulated by the tape worms.

The mucous membranes of the eyes, nose, and mouth become grayish-white and the skin tight; an enormous appetite occurs in the early stages and diminishes as the disease progresses. After a time the animal becomes very weak, with tottering gait or cannot stand at all; the abdomen may be tucked up or may be distended with gas. In this weakened condition the animal becomes a prey to numerous other parasites which hasten its death. Even in mild infestations, if something is not done to rid the animal of tape worms death will result in a short time.

### Treatment.

Numerous treatments have given fair to good results, but no treatment is a success unless it removes the head of the tape worm. The treatments are given in doses intended for young animals and may be doubly increased for older animals. Always take into consideration the apparent strength of the animal. Goats in all cases should receive a somewhat smaller dosage, as, for some unknown reason, they do not stand the action of the drugs as well as sheep. To get the best results, all animals should be deprived of feed and water for at least twelve hours. Good results can be had without withholding feed, but in this case some laxative or purge should be given twelve hours before treatment. Two to four ounces of castor oil or six ounces of Epsom salts thoroughly dissolved in a pint of water give the best results.

After treatment and expulsion of the worms, which generally takes from six to twelve hours, the animals should always be changed to a fresh pasture. Reinfestation will take place if the change is not made, because the embryo worms will live for considerable time under favorable weather conditions.

Kousso in one and one-half dram doses or Koussin in two grain doses have given very good results.

Powdered male fern or etherial extract of male fern is given in one-ounce doses, combined with two to four ounces of castor oil and preferably followed in two to six hours hours by the same amount of castor oil.

Oil of turpentine is given in two-ounce doses combined with four ounces of linseed oil or milk, followed in several hours by two to four ounces of castor oil.

In all cases best results and more rapid recovery can be had when the animals are given some supplementary feed for a month or two after treatment. Cottonseed cake or meal, oats, corn, or milo will be found beneficial.

The same precautions to prevent infestation with tape worms should be followed as in the prevention of liver fluke.

## NODULAR DISEASE.

This is a disease which may be confused with tuberculosis of the intestines, but the latter is a very uncommon disease among sheep and goats and is caused by a germ, while nodular disease is caused by a worm termed Oesophagostomum columbianum.

This disease is quite prevalent in locations where the range is flat, rainfall excessive, and weather humid. The nodules produced by this worm in the intestinal walls vary in size from that of a pin head to a pea and sometimes larger, being filled with a greenish-blue, cheese-like material. Usually one or more worms about one-fourth to one-half inch long are found in this material, but there are times when no worms are found, having escaped to the intestines and passed from the body or having started a new nodule.

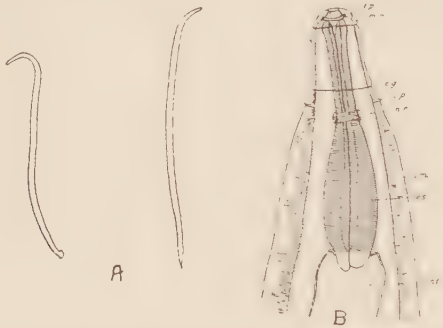


Figure 8. (Nodular Disease.) A, Oesophagostomum columbianum, male at left, female at right; *vulva x5; B, Oesophagostomum columbianum, anterior extremity, ventral view, enlarged. (After Underhill.)

The mode of infestation is thought to be similar to that of the stomach worm, the eggs being hatched outside of the body and going through several moults before attaining the infestive stage.

When this larval worm is swallowed with the food it passes through the stomach to the intestines; here it burrows into the intestinal walls and produes a nodule. The greatest infestations are found in aged animals, however infestations have been seen in young animals.

### Symptoms.

The disease being of a chronic nature, no pronounced symptoms will be seen for some time after infestation has taken place. A gradual unthrifty condition develops, usually accompanied by diarrhea, and a bleaching of the visible mucous membranes, which, however, is not as constant a symptom as of stomach worms. There are digestive disturbances causing a lack of appetite and diarrhea of varying degrees which when once established is of an unusually persistent nature and is most likely the cause of emaciation. Most often the death of the animal follows when this parasite is aided by numerous other parasites. Both sheep and goats show practically the same symptoms. As it is hard to diagnose from external examination several of the poorest animals should be killed and a search made for the nodules and the worms.

### Treatment.

Up to the present time no treatment of value has been developed because of the inability to reach the worms with medicinal agents, they being protected inside the nodule. Prevention consists of supplying good water, plenty of salt, and change of pastures, allowing each pasture to remain idle or grazed by other stock (cattle or horses) for at least one year. Low, poorly drained pastures should be avoided as much as possible. Young registered stock may be fed in bare lots, which must be cleaned often, in which case infestation may be practically prevented until the animals are put on pasture.

## WHIP OR CAECUM WORMS.

These worms, termed Trichuris ovis, are found in the caecum, a pouch-like structure into which the small intestines empty and the large intestines open. The body of the worm is grayish-white in color, about

Figure 9. (Whip Worms.) Trichuris ovis; male at right, female at left; *vulva x5. (After Underhill.)

three-eighths to one-half inch in length, having long hair-like head parts imbedded under the caecal mucous membrane. Only the body parts will be seen unless the worm has died; then the body and head parts will both be found free in the caecal contents.

Up to the present time, no ill effects have been attributed to these worms in sheep and goats. In most cases, the infestation has been light because a large number of the eggs and larval worms were perhaps destroyed before they reached the caecum. The animals become infested from picking up the eggs with their food. These eggs hatch within the body of the animal and securely attach themselves to the

walls of the caecum. Here the worm matures and lays its eggs, which are passed from the body.

### Treatment.

As in the case of nodular disease, numerous remedies have been used with but little success, the head parts being so well protected. Also, the drugs used may have undergone some chemical change or have been diluted to such an extent as to be of no vermicidal value after having reached the caecum.

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In closing this circular, it might be stated that preventing or minimizing infestations of all internal parasites may be made possible by changing pastures every two months and not overstocking these pastures. Provide good troughs for water and salt: fence all waterholes which remain full for long periods of time. When a new animal is brought on the ranch, it should be isolated for at least a month. Sheep and goats should be treated for stomach worms and tape worms, and a careful watch should be kept for any symptoms of disease.

If the above precautions are carefully followed by all ranchmen, losses due to internal parasites of sheep and goats will be reduced.

The introduction of new blood in most instances is the keystone of success in stockraising. But precautions must be taken to prevent the introduction of parasites and disease upon the west Texas ranges when shipments originate in sections known to be infested.

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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 29 APRIL, 1921

DIVISION OF ENTOMOLOGY

# DUSTING COTTON FOR THE CONTROL OF THE BOLL WEEVIL

B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

Circular No. 29. April, 1921.

# DUSTING COTTON FOR THE CONTROL OF THE BOLL WEEVIL.

By M. C. Tanquary and H. J. Reinhard.

During the season of 1920, the Division of Entomology of the Texas Agricultural Experiment Station, conducted two series of experiments to test the efficiency of the dusting method for the control of the cotton boll weevil under Texas conditions. This method has been developed on a large scale by Mr. B. R. Coad of the U. S. Bureau of Entomology at Talullah, Louisiana. The work done by Mr. Coad during the past several years has shown that under conditions prevailing in the Mississippi Delta region the boll weevil may be profitably controlled by poisoning with calcium arsenate on land that will yield as much as one-half bale of cotton per acre. The object of our experiments was to determine whether this method would be equally successful under Texas conditions.

One series of experiments was carried on with hand guns and the other with a large traction duster drawn by a team. Calcium arsenate, conforming to the government specifications for that material, was the poison used. These specifications as worked out by Mr. Coad are as follows:

Not less than 40 per cent. arsenic pentoxide.

Not more than 0.75 per cent. water soluble arsenic pentoxide.

Density not more than 100 or less than 80 cubic inches a pound.

A description of the experiments will be given first, followed by conclusions drawn from the results of the experiments, and recommendations based upon those conclusions.

## EXPERIMENT WITH HAND DUSTERS.

For the purpose of this experiment a plat of cotton containing about two acres, on land belonging to the Division of Entomology, was divided into three plats as shown in the accompanying diagram. Plat A (30 rows) contained about one acre; plat B (15 rows) and plat C (15 rows) about one-half acre each.

The poison was applied early in the morning on the dates given in the table, usually between 4 and 8 o'clock, in order to take advantage of the presence of dew. It was found that the amount of dew varied considerably, some mornings being very heavy, other mornings quite light. Some mornings the dew formed fairly late. On one occasion there was very little dew when the dusting was commenced at 4 o'clock, but by 6 o'clock the plants were dripping.

The percentages given in the table represent percentages of infestation and were arrived at in the following manner: One hundred squares

Figure 1 Dusting cotton with calcium arsenate to control the boll weevil. (Photograph by A. K. Short.)

were counted from near each corner of the plat and one hundred from the center. The number of squares that were infested out of each one hundred was noted and this was taken to represent the percentage of infestation in the particular part of the plat from which they were taken. The average of these percentages was then taken to represent the percentage of infestation in the plat. Thus each percentage given in the tables represents a count of five hundred squares.

Table 1.

| | Date. | Plat B, 15 rows | Check, (not dusted) 15 rows | Plat A, 30 rows |
|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. |
| First count | July 21, 1920 | | | |
| First dusting | July 22–23, 1920 | 20.8 | 25.4 | 57.2 |
| Second count | July 26, 1920 | | | |
| Second dusting | July 26–27, 1920 | 40 | 50 | 47.8 |
| Third count | July 31, 1920 | | | |
| Third dusting | July 30, 1920 | 31.2 | 53.4 | 32.6 |
| Fourth count | Aug. 5, 1920 | | | |
| Fourth dusting | Aug. 2, 1920 | 23.2 | 60 | 25 |
| Fifth count | Aug. 9–10, 1920 | | | |
| Fifth dusting | Aug. 4–5, 1920 | 31 | 73.6 | 30 |

Reference to Table 1 will show that the percentage of infestation was high before the dusting was begun; ranging from 20.8 per cent. in plat B to 57.2 per cent. in plat A, the check showing 25 per cent. The dusting should have been begun a week or ten days earlier.

The second count was taken on July 26, five days after the first count. The result of the second count showed an increase of infestation in plat B, and an equal increase in the check plat, and a decrease in plat A. The third and fourth counts taken at intervals of five days showed a gradual decrease of infestation in the dusted plats and a gradual increase of infestation in the check plat.

There are two things shown in the table that are contrary to what would be expected, and require some explanation. One is the increase in percentage of infestation in plat B between the first and second counts, and the other is the increase in infestation between the fourth and the fifth counts.

At the beginning of the experiment the percentages of infestation were obtained in all three plats on the afternoon of July 21, with the expectation that both plats A and B would be dusted the following morning. It happened, however, that only plat A was dusted on July 22 and plat B not dusted until July 23, or two days after the count was made, so that the percentage of infestation must have been considerably higher than 20.8 per cent. when the poison was applied.

The increase in percentage of infestation in the poisoned plats A and B, between the fourth and the fifth counts, is apparently due to the rainfall and high humidity during that period. During the month of August and the first week of September the rainfall was excessive, the total amounting to more than 12 inches for that period. These rains interferred with further dusting on these plats, and under favorable

climatic conditions for weevil development the percentage of infestation increased very rapidly. On August 16 the percentages were found to be: Plat B, 84.8 per cent.; check, 91.6 per cent.; plat A, 79.4 per cent. The rainy weather still continuing, the infestation increased until it was soon practically 100 per cent. on both the dusted and undusted plats.

EXPERIMENTS II AND III.

In Experiments II and III a large cart duster drawn by a team was used. This machine was furnished for the experiments by the Niagara Sprayer Company. Opportunity to conduct these experiments on a larger scale was very kindly furnished by Mr. E. H. Astin on his ranch in the Brazos bottom about twenty-one miles northwest from College Station.

The accompanying tables show the results of these experiments. The percentages here given were obtained in the same manner as those in the experiment given above, so that each percentage given represents the count of 500 squares. It will be noted that between July 17 and July 31, the percentages of infestation in the dusted plats, plats A, B, and C, were reduced from 67 per cent. to 13 per cent., from 24 per cent. to 9.2 per cent., and from 41.2 per cent. to 12 per cent., respectively, and that during the next five days the infestations increased to 15.2 per cent., 11 per cent., and 16.4 per cent., due to rainfall and a continuously humid atmosphere making ideal conditions for weevil development. During the time covered by the tables the percentages of infestation in the five check plats changed from 59.6 per cent. to 75.2 per cent., from 52 per cent. to 47.6 per cent., from 19.2 per cent. to 56.6 per cent., from 58.4 per cent. to 73.2 per cent., and from 34.2 per cent. to 63.8 per cent.

Table 2.

| | Date. | Check. | Plat A. | Check. | Plat B. | Check. |
|---|---|---|---|---|---|---|
| | | Per cent. | Per cent. | Per cent. | Per cent. | Per cent. |
| First count | July 17, 1920 | | | | | |
| First dusting | July 17, 1920 | 59.6 | 67 | 52 | 24.6 | 19.2 |
| Second count | July 21, 1920 | | | | | |
| Second dusting | July 22, 1920 | 62 | 50 | 56.4 | 20 | 51 |
| Third count | July 27, 1920 | | | | | |
| Third dusting | July 26, 1920 | 65.2 | 31.4 | 55.2 | 14 | 62.4 |
| Fourth count | July 31, 1920 | | | | | |
| Fourth dusting | July 30, 1920 | 47.6 | 13 | 32.8 | 9.2 | 49.4 |
| Fifth count | Aug. 4, 1920 | 75.2 | 15.2 | 47.6 | 11 | 56.6 |

Table 3.

| | Date. | Check. | Plat C. | Check. |
|---|---|---|---|---|
| | | Per cent | Per cent. | Per cent. |
| First count | July 19, 1920 | | | |
| First dusting | July 20, 1920 | 58.4 | 41.2 | 34.2 |
| Second count | July 26, 1920 | | | |
| Second dusting | July 24, 1920 | 70.4 | 32.8 | 65.2 |
| Third count | July 31, 1920 | | | |
| Third dusting | Aug. 4, 1920 | 71.2 | 12 | 54.4 |
| Fourth count | Aug. 5, 1920 | | | |
| Fourth dusting | Aug. 9, 1920 | 73.2 | 16.4 | 63.8 |

During the time of the experiments as indicated by the tables the average infestation of the three poisoned plats decreased from 44.3 per cent. to 14.2 per cent., while during the same time the average infestation of the check plats increased from 44.7 per cent. to 63.3 per cent. Up to the time the extremely wet weather began the infestation on the poisoned plats was reduced to an average of 11.4 per cent.

In all the check plats except the middle check of Experiment II, there was a very decided increase in the percentage of infestation between the first and last counts. There are two things which partly explain the decrease in the percentage of infestation in this check: first, the presence of a wide poisoned plat on each side; second, the fact that at the time of the second dusting, the operator of the dusting machine overlooked the markers and dusted eighteen of the thirty-six rows of this check. The effect of this one dusting can be noted in the percentage of infestation.

It will be noticed in these two tables just as in Table 1, that due to the hot dry weather of July 24 to July 31 there was a decided reduction in the percentage of infestation in all the plats, both dusted and undusted, except one, and that was in one of the undusted plats where there was an increase of from 70.4 per cent. to 71.2 per cent.

During the first half of August the weather conditions were very unfavorable for applying poison. The high temperature combined with very high humidity gave ideal conditions for weevil development. Consequently when a sixth count was made on August 20 the infestation on both the dusted and undusted plats was practically 100 per cent. If these experiments had been conducted on upland rather than on bottom land it is probable that later dustings could have been applied and the infestation kept at the minimum per cent. indicated in the tables.

Because of circumstances beyond our control, the increased yield on the experimental plats, due to dusting, cannot be accurately given. Mr. Astin makes the statement, however, that with the experiments conducted on his ranch, there was a gain of approximately 30 per cent. on the dusted plats over the undusted plats.

Further experiments along this line will be conducted at the Experiment Station during the coming season.

## CONCLUSIONS.

The above experiments have shown that weevil infestation may be reduced from a high percentage to a very low percentage by dusting

with calcium arsenate, when the poison is applied in dust form with efficient machinery. The dusting should be commenced, however, before a high percentage of infestation is reached. Mr. Coad recommends that the first dusting be made when the infestation is from 10 to 20 per cent.

It should be remembered that the mere poisoning of the weevil will not produce cotton. Every other effort, such as careful preparation of the seed-bed, the use of good seed, thorough cultivation, etc., should be made to produce a good crop of cotton.

This method of control is an expensive one and should be used only on cotton that is likely to be badly infested with weevil, and that would make as much as one-half bale per acre if free from weevil infestation. The farmer who plans to use this method should give it a fair trial. In the words of Mr. Coad, he should "Do it right or not at all."

The following precautions are given as a guide for those who are planning to use this method this year:

1. Equip yourself with an approved type of dusting machine. Application by the old pole and bag method is useless.
2. Use calcium arsenate conforming with the specifications recommended by the U. S. Department of Agriculture. Otherwise your cotton may be seriously injured. Through your county agent send a sample (not less than one-half pound) to the government laboratory, Tallulah, Louisiana, for analysis.
3. Begin poisoning when from 10 to 20 per cent. of the squares are punctured by the weevil.
4. Apply poison when the air is calm and the plants are moist. This condition most generally obtains at night or early morning.
5. Use from 5 to 7 pounds calcium arsenate per acre.
6. Apply poison about every fourth or fifth day for the first three or four applications.
7. Do not attempt to poison too large an acreage with one machine. Allow one hand gun for from eight to ten acres, and one two-horse cart duster for from seventy-five to one hundred acres. The one-mule cart duster, a new type of machine, is being put on the market this year for the first time. It is estimated to take care of about sixty acres.
8. This method is a proved success under conditions obtaining in the Mississippi Delta region. Since it is still in the expermiental stage under certain conditions, it is urged that all those using this method leave a number of rows unpoisoned for comparison of results.

The following list of firms manufacturing cotton dusting machinery is complete so far as information we have at the present time. It is likely that many other firms will be added to this list in the near future. The inclusion of a firm's name does not mean that its product has been officially tested and endorsed.

Albert Lea Sprayer Co., Albert Lea, Minn. (Hand gun.)
Avery & Company, Peoria, Ill.
Bean Spray Pump Co., Lansing, Mich. (Cart duster.)
Cincinnati Stamping Co., Cincinnati, Ohio. (Hand gun.)

Edwards Dust Spraying Mch. Co., Hopkinsville, Ky. (Hand and saddle.)

Excelsior Insecticide Duster Co., 72 St. Nicholas Place, New York City. (Hand gun.)

Feeny Mfg. Co., Muncie, Ind. (Hand and saddle.)

Leggett & Bros., 301 Pearl St., New York City. (Hand gun.)

Nitrate Agencies Co., 233-245 W. First St., Bayonne, N. J.

Springfield Dry Powder Sprayer Co., Springfield, Tenn. (Hand gun.)

D. B. Smith & Co., Utica, N. Y. (Hand gun, one mule.)

Ward-Love Pump Corporation, Rockford, Ill. (Cart and one mule.)

S. L. Allen & Co., Fifth St. and Glenwood Ave., Philadelphia, Pa.

Bateman & Companies, Inc., 347 Madison Ave., New York City. (Cart duster.)

Champion Corporation, Hammond, Ind. (Cart duster.)

Dust Sprayer Manufacturing Co., 1222-4 West Ninth St., Kansas City, Mo. (Power and cart.)

Electric Wheel Company, Quincy, Ill.

Frank & Hedden Co., 183 First St., Jersey City, N. J. (Cart duster.)

Field Force Pump Co., Elmira, N. Y.

National Mfg. Co., Des Moines, Iowa. (One mule duster.)

Niagara Sprayer Co., Middleport, N. Y. (Cart and power.)

Peerless Dust Gun Co., 118 Noble Court, Cleveland, Ohio. (Hand gun.)

Tow Lemons Mfg. Co., Springfield, Tenn. (Hand gun.)

The National Manufacturing Co., Des Moines, Iowa. (One horse duster.)

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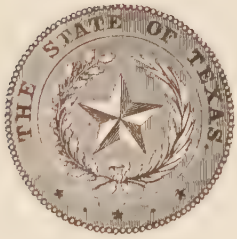
TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 30 APRIL, 1923

DIVISION OF ANIMAL INDUSTRY

# THE PRACTICABILITY OF THE MILKING MACHINE




B. YOUNGBLOOD, DIRECTOR,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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Circular No. 30. April, 1923

# THE PRACTICABILITY OF THE MILKING MACHINE

BY

JAY L. LUSH, ANIMAL HUSBANDMAN

## INTRODUCTION

Mechanical devices for milking cows have been in process of invention and improvement for the last fifty years, but it is only within the last twenty years that they have appeared on the market in the United States in forms reliable enough and efficient enough to warrant their serious consideration for ordinary farm or commercial dairy use. Their general use began somewhat earlier and is today more extensive in countries like New Zealand and Australia where labor-saving devices are more in demand than they are even in the United States.

There was a great diversity among the early machines in design and materials of manufacture and in the principles utilized but the least successful of these have been eliminated until today most milking machines operate upon essentially similar principles and differ from each other only in details of construction, location of different parts, etc. Some of these details are of considerable importance in determining the life of the machine and its upkeep cost and the convenience of using it, but no comparison of different makes of machines will be attempted here because there are more than half a dozen prominent makes of milking machines and it would be impossible to discuss them fairly in a short paragraph or two. The Pine Tree machine was used for the experiment to be described here and the results may be regarded as fairly typical of all the leading makes of machines.

The agricultural experiment stations began to investigate the milking machine as soon as it became improved so far that its friends claimed that it was practical. The early experiments were for the most part planned to find out whether milking machines would really work and were reliable. Then attention was turned to their influence on milk yield and more recently it has been concentrated on their influence on the quality of milk and on the economical aspects of their use.

The data reported here were gathered during the past three years at the dairy farm of the Texas Agricultural Experiment Station, Substation No. 10, College Station, Texas, and are presented in behalf of a better understanding of the milking machine question.

## EFFECT OF MACHINE MILKING UPON THE YIELD OF MILK.

The results of other experiment stations and the experiences of practical dairymen have tended to show that the use of a milking machine has little or no influence upon the quantity of milk which a cow will produce. At least this has seemed to be true of the modern and

improved types of milking machines where the cows were stripped afterward by hand. Some of the earlier experiments with less improved types of machines have shown slight decreases when the milking machine was used and it is no doubt true, as many practical dairymen affirm, that some cows respond better to a milking machine than others just as some cows are easier to milk by hand than others. The impression that there is a very small but slight decrease in the milk yield where the machine is used is so general that a large number, perhaps a majority, of dairymen who have cows on official test for the Register of Merit or Advanced Registry insist that those cows be carefully milked by hand although they are willing to use the machine for their cows not on official test.

If the milk which a cow gives were as definite a quantity as the amount of water which will flow through a pipe of a given size at a given pressure and a given temperature, it would be easy to find a very definite and very exact answer to the question of the influence of the milking machine upon the amount of milk which a cow will give. However, the milk flow is influenced by many other factors such as the inherent ability of the cow to produce milk, her age, the length of time since she last calved and before she is to calve again, the kind and amount of feed, the season of the year, and the care and gentleness with which she is handled, etc., and it is not easy to find an exact answer. The following plan was used to secure the most accurate answer possible: The cows available for experimental purposes were divided into two groups, as nearly equal as possible, by pairing a cow in one group with one in the other group as nearly like her in the period of lactation and previous daily milk record as possible. Some of the cows went dry sooner than expected and the dry summer affected the pastures badly so that the milk flow of all of them was less than was expected. For cows which went dry, other cows were substituted, and so there is more variation in individuality than is desirable, but on account of the pairing of the cows with each other as far as possible this variation is not enough to prejudice the results in either direction. One group of cows was milked by machine and the other by hand for thirty days, beginning April 22, 1922. Then they were changed and those which had been milked by hand were milked by machine and vice versa for the next sixty days, when they were changed again for sixty days, at the end of which time they were again changed and sixty days later were changed for the fourth and last time and were milked for the eighth thirty-day period in the same manner as they were during the first period. Thus the cows in group A were milked by hand during the first, fourth, fifth and eighth thirty-day periods and by machine during the second, third, sixth, and seventh thirty day periods. The cows in group B were milked by machine during the first, fourth, fifth, and eighth thirty-day periods and by hand during the second, third, sixth, and seventh thirty-day periods. The change in the methods of milking was made at sixty-day intervals because it is commonly claimed that it requires some time for cows used to one method of milking to accustom themselves to a change and therefore the records of the first half and the last half of each sixty-day period were kept separately.

The milk production by each cow for each thirty-day period is shown in Table 1 and Table 2.

**TABLE 1.**

**Milk Production in Pounds for Each Thirty-Day Period—Group A.**

| Cow's Number | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth | Average |
|---|---|---|---|---|---|---|---|---|---|
| Method of milking | Hand | Machine | Machine | Hand | Hand | Machine | Machine | Hand | |
| Average loss per cow: Pounds | ..... | 107.4 | 63.1 | 104 7 | 101.2 | 59.9 | 132.9 | 97.2 | ..... |
| Per cent | ..... | 16.9 | 10.5 | 17.0 | 19.7 | 11.8 | 21.7 | 15.4 | ..... |
| 0 | 804.1 | 506.9 | 559.8 | 445.9 | 223.4 | ..... | ..... | ..... | 508.0 |
| 3 | ..... | ..... | 883.4 | 711.2 | 628.4 | 605.8 | 479.9 | 345.9 | 609.1 |
| 11 | 350.2 | 307.9 | ..... | ..... | ..... | ..... | ..... | ..... | 329.0 |
| 21 | 290.7 | 237.0 | ..... | ..... | ..... | ..... | ..... | ..... | 263.8 |
| 47 | 508.1 | 401.6 | 282.2 | ..... | ..... | ..... | 804.9 | 749.9 | 549.3 |
| 68 | 939.5 | 854.6 | 725.6 | 608.2 | 519.8 | 468.2 | ..... | ..... | 686.0 |
| 71 | 557.5 | 506.4 | 453.6 | 350.4 | 234.1 | ..... | ..... | ..... | 420.4 |
| 107 | ..... | 609.5 | 561.9 | 474.4 | 438.0 | 387.1 | 323.1 | 280.0 | 439.1 |
| 116 | 1039.1 | 893.3 | 768.1 | 598.7 | 417.1 | 254.3 | ..... | ..... | 661.8 |
| 117 | 560.6 | 497.3 | 452.8 | 354.7 | 229.1 | ..... | ..... | ..... | 418.9 |
| 120 | ..... | ..... | ..... | ..... | ..... | ..... | 999.6 | 798.3 | 898.9 |
| 122 | ..... | ..... | ..... | ..... | ..... | 752.8 | 577.5 | 469.6 | 600.0 |
| 129 | 670.4 | 548.4 | 509.1 | 533.6 | 522.6 | 439.5 | 259.1 | ..... | 497.5 |
| 146 | ..... | ..... | ..... | 552.7 | 506.4 | 518.1 | 443.0 | 408.7 | 485.8 |
| 111 | ..... | ..... | ..... | ..... | ..... | 966.0 | 789.2 | 684.2 | 813.1 |

**TABLE 2.**

**Milk Production in Pounds for Each Thirty-Day Period—Group B.**

| Cow's Number | First | Second | Third | Fourth | Fifth | Sixth | Seventh | Eighth | Average |
|---|---|---|---|---|---|---|---|---|---|
| Method of milking | Machine | Hand | Hand | Machine | Machine | Hand | Hand | Machine | |
| Average loss per cow: Pounds | ..... | 85.0 | 21.2 | 94.2 | 85.7 | 20.5 | 57.0 | 78.9 | ..... |
| Per cent | ..... | 14.5 | 3.8 | 16.9 | 16.4 | 4.7 | 11.1 | 14.4 | ..... |
| 6 | 893 9 | 737.5 | 710.4 | 533.8 | 377.2 | 304.6 | ..... | ..... | 592.9 |
| 11 | ..... | ..... | ..... | ..... | ..... | ..... | 726.4 | 569.7 | 658.1 |
| 52 | 407.0 | 401.6 | 388.3 | 263.4 | ..... | ..... | ..... | ..... | 365.1 |
| 58 | 490.1 | 372.1 | 314.3 | 187.4 | ..... | ..... | ..... | ..... | 341.0 |
| 95 | 616.6 | 538.1 | 514.5 | 416.0 | 263.5 | 216.6 | ..... | ..... | 394.2 |
| 96 | 795.1 | 653.7 | 590.5 | 496.0 | 417.2 | 414.4 | ..... | ..... | 561.1 |
| 103 | ..... | ..... | 715.9 | 640.7 | 566.4 | 506.2 | 430.6 | 343.0 | 533.8 |
| 113 | ..... | ..... | ..... | ..... | ..... | 682.8 | 684.3 | 632.8 | 666.6 |
| 119 | ..... | 1039.1 | 1033.1 | 987.1 | 936.0 | 993.1 | 974.1 | 936.6 | 985.6 |
| 127 | 421.1 | 379.6 | 374.9 | 342.9 | 298.5 | 279.2 | 214.9 | 128.5 | 304.9 |
| 128 | 605.1 | 548.8 | 521.7 | 428.7 | 338.8 | 330.0 | 184.8 | ..... | 422.6 |
| 131 | 458.8 | 376.0 | 408.2 | 333.6 | 295.3 | 285.1 | 245.6 | 192.1 | 324.3 |

These tables show that there was a decrease, due to the advance in lactation period and to the effect of drouth on the pasture, in the milk production of every cow from one period to the following with but six exceptions in the whole experiment. They also show considerable irregularity without regard to whether the cows were milked by hand or machine, thus showing that the method of milking is not nearly as important an influence on milk yield as many other factors. However, on the whole the decreases are not so great when the change is from machine milking to hand milking as when the reverse is true, and

not as great when hand milking is continued as when machine milking is continued. These differences are so irregular that a mere inspection of Tables 1 and 2 is not enough to show whether or not they really mean something or are accidental. Therefore, the percentage decrease in the milk-production for each successive period was figured separately for every cow. All such percentage decreases for cows undergoing the same changes in method of milking were averaged together with the following results:

TABLE 3.

| Kind of Change in Method of Milking | Number of cases | Average per cent of decrease |
|---|---|---|
| Machine continuously | 22 | 16.1±1.57 |
| Machine to hand | 31 | 13.1±1.12 |
| Hand continuously | 24 | 13.6±2.03 |
| Hand to machine | 31 | 17.3±1.96 |

This shows the apparent slight superiority of hand milking but when the "probable errors"* are taken into consideration the differences are so small that they may have been due to chance and might not occur if the experiment were repeated. Thus the largest difference (that between the "Machine to Hand" and the "Hand to Machine" percentage decreases) is 3.9±2.26%. This difference is only about one and three-quarters times as large as its "probable error" and this means that there is about one chance in four that the difference was an accident of this experiment and would not occur again. This of course leaves the milking machine under suspicion of having really caused the slightly greater decrease in milk yield when it is used, but it does not prove it.

The effect of the milking machine upon milk yield may be summarized by saying that it is doubtful whether it has any effect at all and it is certain that such an effect is very slight if it exists. The owners of cows on official test will find it well to continue to milk them by hand to give themselves the benefit of the doubt, but for other cows this possible effect of the machine on milk yield is certainly so slight that it need not enter into a consideration of whether or not the machine should be used. It should be remembered that in this experiment the cows used were accustomed to both methods of milking and that except for a very few days, the hand milking was done by an experienced and rapid milker. The change from one type of milking to another does not seem to have affected the yield noticeably. The hand-milked cows suffered a few times from a change of milkers but this was offset by a similar misfortune to the machine-milked cows once in each the second, third, and fourth months when the power was cut off and all or part of the machine-milked group had to be milked by hand.

Figures 1 and 2, which show graphically the decrease in the milk

*±1.57 and ±1.12, etc., are what mathematicians call, "the probable error." This does not mean that there are any mistakes in the records but only shows how likely it is that the result would be the same if the experiment were conducted over again. Thus 16.4±1.57 means that if the experiment were conducted over again with the same cows and under the same conditions it is not likely that the average per cent of decrease where the machine is used continuously would be greater than 16.4±1.57 or 17.97 nor less than 16.4—1.57 or 14.83.

yield for each group from period to period, emphasize the tremendous influence of season and feed on milk production and make it seem more probable that the use of the machine did not influence milk-production at all. The slopes of the lines are the same throughout most of the periods and yet the two groups were always being milked by opposite methods. When the decrease was large for the machine-milked group it was also large for the hand-milked group and when one decreased only a little the other did likewise. The differences which do exist favor the hand milking except for the decreases between the fourth and fifth periods and a slight difference in the seventh to eighth periods. Figure 1 shows the decrease in percentages, while Figure 2 shows the yield in pounds.

## THE EFFECT OF MACHINE MILKING UPON THE QUALITY OF MILK.

The results from other experiment stations have shown that the use of the milking machine has no effect upon the percentage of butter fat in the milk if the cows are stripped by hand afterward. The milk obtained by stripping is richer than the first milk drawn and of course if the cows were not stripped, the effect of using the machine would be to lower the fat percentage. However, failure to strip the cows would also soon lead to disaster by drying the cows up and therefore it is a practice too dangerous to use except possibly for an isolated milking period in time of great labor emergency.

There is only one other important respect in which the milking machine can affect the quality of the milk and that is the cleanness of the milk. The standard of cleanness most commonly used is the number of bacteria found in a cubic centimeter of milk. This is not an absolutely accurate standard because dirt from different sources may contain different quantities of bacteria. However, it is roughly accurate and is the best practical standard which is commonly used. Normally produced milk is never absolutely free from bacteria no matter how much care is used in its production. Most cities and states which have rules upon the subject at all have arbitrarily adopted 10,000 bacteria per cubic centimeter as the maximum number which milk can contain and be classed as "certified" milk. It requires continual care and scrupulous cleanliness to produce milk with as low a bacterial count as this and most producers do not attempt it unless they are selling whole milk to a special trade and getting extra prices for it. Ordinary farm-produced milk may easily contain as many as 1,000,000 bacteria per cubic centimeter if no extra attention is paid to cleanliness of the stables, cows, and utensils. It should be pointed out that the number of bacteria is not nearly as important from a health standpoint as the kind of bacteria. A few tuberculosis bacteria are more to be dreaded than many millions of lactic acid bacteria. The bacterial count is useful only as a general indicator of the care and cleanliness with which the milk has been produced and of the refrigeration under which it has been kept between the time when it was drawn from the cow and the time when the sample was taken for the bacterial count.

The facilities for bacteriological examination which were at the disposal of this Station were so limited and the study of this phase of

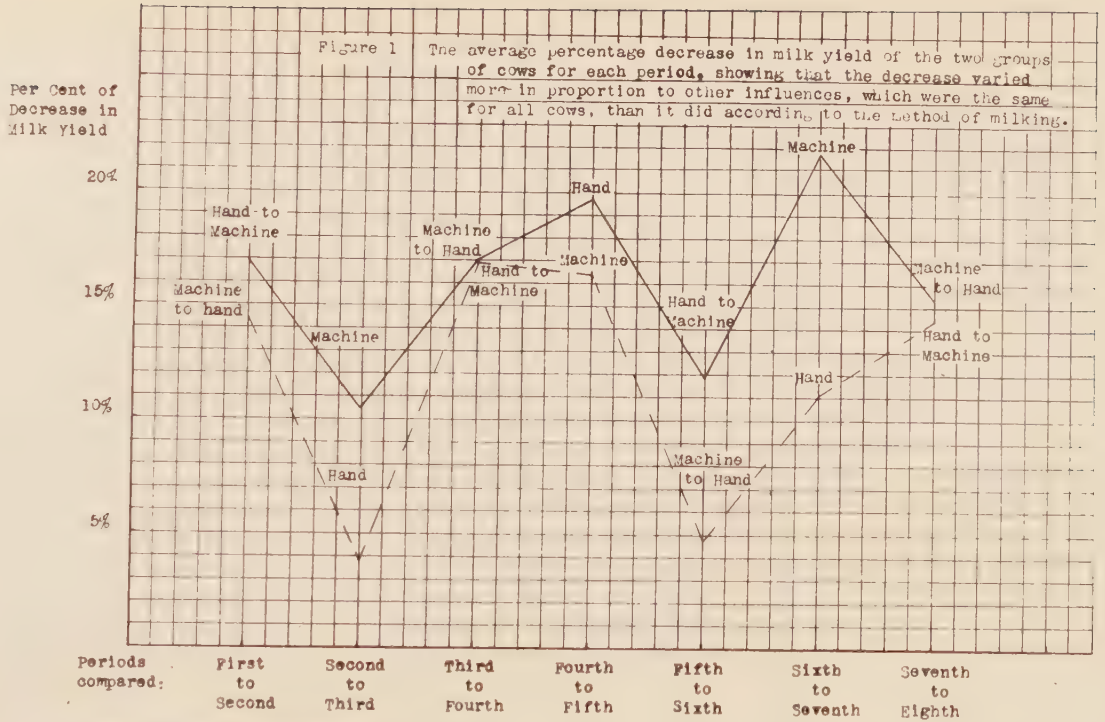


Figure 1 The average percentage decrease in milk yield of the two groups of cows for each period, showing that the decrease varied more in proportion to other influences, which were the same for all cows, than it did according to the method of milking.

The solid line indicates Group A.
The dotted line indicates Group B.

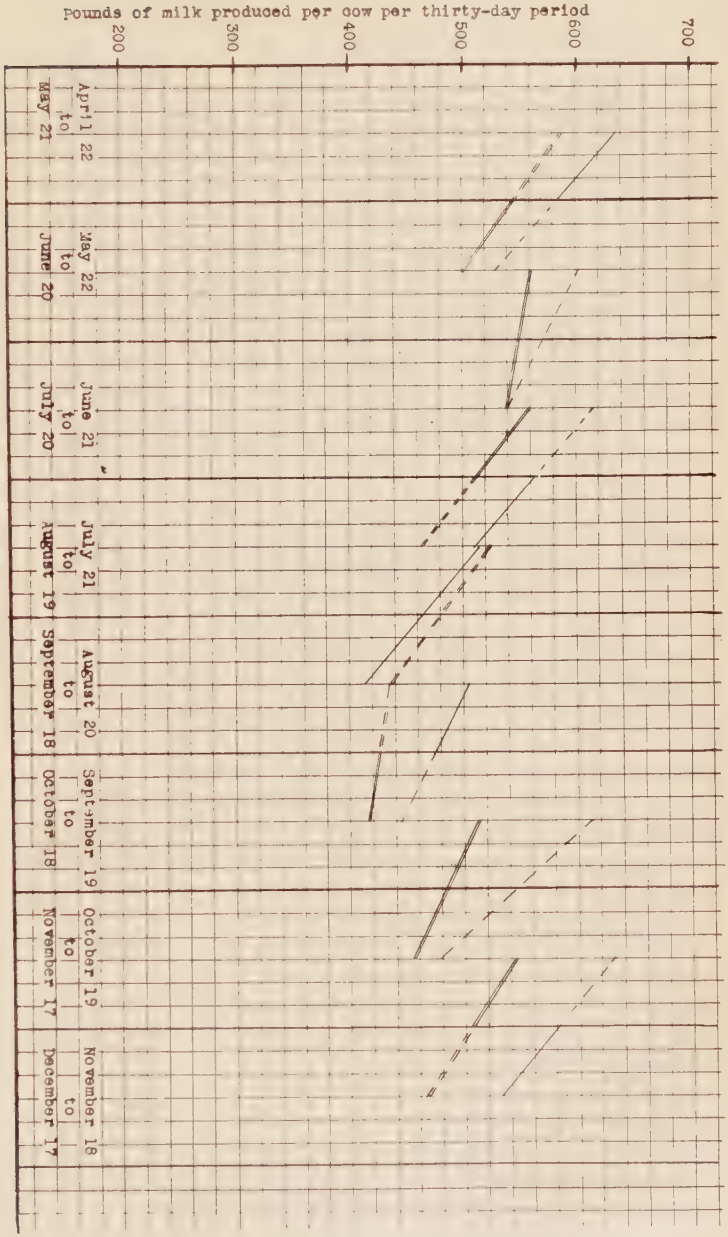


Fig. 2. Showing the average milk production per cow for comparable groups of cows.
Solid line indicates hand-milking and broken line indicates machine milking.
Single lines indicate cows of Group A, and double lines indicate cows of Group B.

the milking machine question by other experiment stations (especially the New York Station) has been so thorough that no attempt was made to do more than make a bacterial count once each week of samples of morning and evening milk produced by each method.

It soon became apparent that the bacterial count was higher for the machine-milked samples than it should be and when the reason for this was sought, it was discovered that the sterilizing solution being used to cover the rubber parts between milkings was not the one recommended by the latest investigators but consisted merely of one pint of clean salt dissolved in five gallons of clean water. This is the one shown in the table as the "First" solution. Then the solution was changed to the one recommended in New York Agricultural Experiment Station Bulletin No. 492. This one which is described in detail below consisted of a stronger salt solution combined with a hypochlorite solution and is shown in Table 4 as the "Second" solution. Then because the hypochlorite solution is somewhat more trouble to maintain than a pure salt solution, a saturated solution of common salt was used. This is shown in the table as the "Third" solution, and was made by putting into five gallons of water enough salt that some always remained undissolved on the bottom of the stone jar in which the solution was kept.

**TABLE 4.**

**Average Number of Bacteria per Cubic Centimeter of Milk.**

| Date | Evening Milk | | Morning Milk | |
|---|---|---|---|---|
| | By machine | By hand | By machine | By hand |
| (First Solution) Average | 273,925 | 114,725 | 105,881 | 86,780 |
| April 21 | 43,000 | | 53,000 | |
| April 25 | 338,000 | 80,000 | 163,700 | 46,500 |
| May 2 | 888,400 | 86,500 | 40,000 | 343,000 |
| May 9 | 283,500 | 260,800 | 128,600 | 88,400 |
| May 18 | | | 240,000 | 35,000 |
| May 23 | 313,000 | 230,000 | 187,000 | 30,250 |
| May 30 | 67,500 | 89,500 | 57,000 | 37,000 |
| October 6 | 117,500 | 55,000 | 92,250 | 46,500 |
| October 13 | 96,000 | 42,500 | 106,000 | |
| October 27 | 114,500 | 47,000 | 121,000 | 42,000 |
| November 10 | 69,000 | 69,000 | 57,500 | 60,500 |
| (Second Solution) Average | 27,800 | 23,306 | 22,050 | 18,606 |
| November 24 | 62,000 | 62,500 | 43,500 | 47,500 |
| January 12 | 38,000 | 25,250 | 36,250 | 23,000 |
| January 18 | 3,950 | 3,000 | 3,200 | 2,125 |
| January 20 | 7,250 | 2,475 | 5,250 | 1,800 |
| (Third Solution) Average | 15,900 | 3,013 | 12,400 | 3,850 |
| January 25 | 4,100 | 2,300 | 3,200 | 3,400 |
| January 27 | 15,000 | 8,000 | 15,500 | 8,500 |
| February 1 | 22,000 | 1,000 | 8,000 | 2,500 |
| February 3 | 22,500 | 750 | 22,900 | 1,000 |

The samples taken from April 25 to May 23, inclusive, were merely placed in the ice box instead of being kept in ice water from the time they were taken until the bacteriologist was ready to work with them and it is evident that considerable growth of bacteria must have taken

place in them. Therefore, it is hardly fair to compare them directly with the counts of April 21 or with the counts of May 30 and later, but they will indicate the comparative cleanliness of machine milking and hand milking. Beginning January 15 a change was made in the method of washing the cows' udders. They had always been washed previously to milking but not nearly as thoroughly as they were after that date. It is evident that the outside of the udder was the main source of contamination previous to this time.

The milk from which the samples were taken was drawn in just the same way as all the other milk produced at that milking period without any extra precautions against contamination. The samples were taken of the milk just as it was being poured on the cooler.

Two things stand out as clearly proven by these results. The first is that on the average the milk produced by hand was cleaner than that produced by machine. This difference is fairly consistent, there being only six cases where the machine produced the cleanest milk and one case where the count was the same. The second fact is that other things are much more important than the method of milking in determining the cleanliness of milk. Thus the abrupt decrease in count between January 12 and January 18 is more significant than any of the comparisons between machine and hand milking. Also the fact that on days when one kind of milk has an unusually high or low bacterial count the other kind of milk varies in the same way, points to other influences as being most important in determining the bacterial count. These other influences are probably mostly one of the following three: first, care or lack of care in washing the milk utensils; second, the thoroughness of the washing of the cows' udders; third, the dryness or dampness of the weather, which would influence the cleanness of the cows' udders, and also the amount of dust and sunlight which would fall on the milking utensils in the sun porch.

The morning milk is slightly cleaner than the evening milk. The difference in this respect may very easily be due to the twelve hours' longer time during which the evening samples were held before being given to the bacteriologist. Whenever the refrigeration was not perfect some slight growth resulted.

As to the relative sterilizing merits of the different solutions in which the rubber parts of the milking machines were kept, it seems clear that the second solution was much more efficient since the percentage differences between the bacterial counts of the milk produced by machine and that produced by hand was less when the second solution was used than while the other two solutions were being used. It is possible that the count of January 25 should really be attributed to the second solution instead of the third since the change in solutions had been made only the preceding day and the third solution was fresh and brine bacteria had not yet had much opportunity to grow. The second solution is recommended, therefore, as being distinctly superior to the other two and as being the one agreed upon as best by a conference of representatives of the milking machine companies and experiment station workers at Ames, Iowa, in February, 1922. The directions given below for preparation of this second solution are copied from Bulletin No. 192 of the New York Agricultural Experi-

ment Station. Too much caution cannot be given, however, against relying upon the solution too much. It will not take the place of care in cleaning and washing. Well-cleaned utensils and a good solution and careful cleaning of the udders are all necessary to the production of milk with a low bacterial count.

The effect of the milking machine upon the cleanliness of milk may be summed up by saying that it will require more care with machine milking than with hand milking to produce milk with a given low bacterial count, but that it is *possible* to produce even certified milk when a milking machine is used if enough care is given to the details of cleanliness.

### *"Chemical Method"*

(Bulletin No. 492, New York Experiment Station)

"After the teat-cups and rubber tubes have been flushed put them into the sterilizing solution and leave them immersed from one milking to the next. Care should be exercised in placing tubes and teat-cups in the solution that no air becomes entrapped in them, for wherever there is air no solution will come in contact with the rubber surfaces. Put the teat-cups into the solution while holding the rubber milk-tube straight up so the air can escape through it.

### *Sterilizing Solution*

"Place 50 pounds of salt in a 20-gallon jar and fill with clean water to within six or eight inches of the top. To this salt solution add one quart of home-made hypochlorite solution (see next paragraph) when the salt solution is first prepared, and add one pint weekly in winter and one pint twice weekly in summer, or add commercial hypochlorite or chloramine solutions according to the directions of the manufacturer. Maintain the sterilizing solution at the original water level by adding salt and clean water as necessary. Make up an entirely new jar of sterilizing solution as soon as the old solution ceases to be clean. Never use a solution for more than six weeks. Care must be observed to see that at no time any dirt or foreign material gets into the solution. In case of such accident empty the solution at once and fill the crock with a fresh solution."

"The home-made hypochlorite solution is made by mixing the contents of one 12-ounce can of chloride of lime with one gallon of water in a 2-gallon covered crock. Be sure the chloride of lime is in a clean, fresh-looking container, plainly marked as to the content of available chlorine. If the label does not have this information, or if the contents look old and caked, the material is worthless. In preparing the hypochlorite solution, first add just enough water to the chloride of lime to make a paste. Stir well and add the balance of the gallon of water. The clear solution which collects is the portion which should be used. This home-made solution is equally effective as the hypochlorite solutions and chloramine powders and costs very much less than any of the commercial preparations."

The reader should write to the manufacturer of his particular make of milking machine for detailed instructions as to cleaning.

## TIME REQUIRED FOR MACHINE MILKING AS COMPARED WITH HAND MILKING

The principal economic argument in favor of the use of the milking machine is the smaller amount of time which it requires for the milking of each cow. In order to find out the true amount of this saving in time, careful records were kept of the time required to milk the cows milked by hand and the cows milked by machine during the eight months of this experiment. One man milked one group of cows by hand at the same time that another man milked the other group of cows by machine, using two single-cow units and stripping each cow after milking. Time was not recorded for each individual cow but the time of the beginning and the ending of both hand and machine milking was recorded at each milking, as well as the number of cows milked. A few cows, not included in other phases of the test, were milked by the machine and the time required on them was computed. For the most part they were cows which were almost dry and, therefore, it did not take long to milk them. This would lower slightly the average time required for machine milking but on the other hand, all the cows, due mostly to a lack of sufficient feed, did not yield as much milk as the average dairy cow. It seems quite likely that the milking machine will make a greater saving of time on high producers than on low producers because of the constant amount of time used in changing the machine, stripping, weighing and emptying the milk regardless of the amount each cow produces. It is believed that the extra saving in time which the machine would show when used on higher producing cows is almost completely offset by the advantage given to the machine in the time figures in this experiment, due to its having milked more than its share of the nearly dry cows.

The number of cows milked by hand varied from 9 to 12, averaging 10.4 head per milking. The average time required per cow was $7.296 \pm .035$ minutes. The number of cows milked by machine varied from 12 to 19, averaging 15.6 cows per milking and requiring an average of $4.643 \pm .016$ minutes per cow per milking. The difference in favor of machine milking is $2.653 \pm .039$ minutes per cow or approximately three cows can be milked by machine while two are being milked by hand. As already mentioned, it is likely that this difference in favor of the milking machine would be greater when the cows used were higher producers. There is, however, one other thing to be considered in this matter of time saving and that is that the milking machine requires some time at each milking to be cleaned and to be put together. Careful records were kept of the amount of time used in caring for the milking machine for one complete week in each of the eight months of this test and this time was found to average 23.7 minutes per day.

The reader will readily see from this why milking machines are not economical where only a small number of cows are milked. The saving in time is a certain number of minutes per cow and not per machine. A man with a small number of cows cannot possibly save very much time by the use of a milking machine whereas the man with many cows may be able to save a large total amount of time. Moreover, the time used in cleaning and care of the machine is almost constant for a

given number of milking units regardless of whether they are used for only a half hour or for three hours at each milking.

The men who operated the milking machine during this test were experienced in handling it and two of them had worked with it for about a year before the test was begun. Therefore, there was not much waste time in handling it, and the variability in the average amount of time required per cow was only 11.16±.25%. The man who did the hand milking regularly was a very fast milker, well acquainted with the peculiarities of each cow, but there were times when it was necessary to use other men for the hand milking due to sickness or discharge of laborers and necessary rearrangement of labor. This is probably the reason for the greater variation in the avcage amount of time required for milking a cow by hand. This variation was 15.56±.35%. Here again the reader will see that the saving in time would be largely determined by individual conditions at each dairy. The man with helpers who liked to milk by hand and were fast at it would not save nearly as much time by the use of a machine as the man whose milkers took little interest in their work and were slow. On the other hand, a man would not want to trust the care of his milking machine to his helpers unless he himself were present at each milking or had at least one careful and conscientious man upon whom he could rely to clean it and care for it correctly.

The milking machine used in this test included only single-cow units; that is, each unit milked only one cow at a time. Practically all manufacturers of milking machines make both single-cow units and double units. The double units milk two cows at once into the same pail, thus making it difficult or impossible to weigh the milk from each cow separately at each milking. Because of the necessity of keeping these exact weights of the milk produced by every cow at each milking, the Station has not considered the use of double units and breeders of purebred cattle who are keeping such records cannot use the double units either, but it is possible that commercial dairies might find it desirable to use a combination of single and double units by weighing the milk only two successive days each week for each cow when she is being milked by the single unit and using a double unit for her the remainder of the time. Thus one man might operate two double units, not weighing the milk, and another could operate two or three single units and weigh each cow's milk. The only important advantage of the double unit, however, is that it does not cost nearly twice as much as the single unit and its upkeep is not quite so expensive. When one considers the confusion which is likely to arise in the changing from one milker to another under such a combination system, it is doubtful whether it could be made to work out smoothly.

No attempt was made in this experiment to milk any cows by machine entirely without stripping afterwards. The experience of other experiment stations and practical dairymen on this point shows that while it may be *possible* to do that with the most efficient modern milking machines it is not a *safe* practice because the small quantity of milk or "strippings" left in the udder is the richest part of the milk and because leaving such strippings there has a tendency to dry up the cow very rapidly. Moreover, the machine takes more time to milk

a quart of strippings than it does to milk a quart of milk from a full udder. The Station has found it most practical to have one man operate two single units, stripping the cows after them and weighing the milk individually. The milk is carried into the milk room for weighing, an average distance of about sixty feet. It is likely that in the average dairy, where cows with a larger yield are milked and where the milk is not carried so far, one man could operate three single units, but there are probably very few dairies where one man could keep up with more than three single units or more than two double units. The fact that it is *possible* to milk occasionally without stripping when a machine is used may be of some importance in helping to tide the dairyman over emergencies such as epidemics of sickness among his helpers or their quitting without warning, but, on account of its tendency to dry up the cows, this should be done only as a last resort.

## COST OF OPERATION

The following figures on the cost of operation should not be regarded as an absolute standard which all users of milking machines will equal. Most of them were taken and most of the expenses were incurred with only commercial conditions in mind. The figures cover the first three years during which the milking machine was operated, from November, 1919, to October, 1922. Their chief value to the prospective purchaser of a milking machine or to the present owner of one who wishes to know more exactly its costs of operation, is that they may suggest expenditures which he has overlooked in his own accounting and they will give him a standard of comparison of his own costs with those of a modern dairy which is run under nearly commercial conditions. Therefore, these figures are given in some detail with comments on each item.

The first cost of the milking machine, consisting of air pump, vacuum tank, and three single-cow units, together with the labor of installing, was $418.26. Electricity was the source of power and a three-horsepower 60 cycle electric motor valued at $120 was used to operate the pump. This motor is at least twice as large as is necessary for the operation of the suction pump and was used only because it was already the property of the Station and was not needed for other purposes. Other users of milking machines can effect a considerable saving on this item by purchasing a gasoline engine or motor which is only a little larger than is estimated to be necessary. The total first cost of the entire outfit to the Station was $538.26. Besides the repairs and the operating expenses, which are considered below, there are two items of fixed cost to be charged against this investment. The first is interest on the investment and the second is depreciation. Depreciation is distinct from repairs because there will come a time when the machinery will have to be replaced by new even though it has been patched and kept continually in actual running condition. That may come because the machinery is so nearly worn out that the repairs and inconvenience caused by breakdowns are too expensive, or it may come because of the invention of new machinery which will make the old obsolete. It is impossible to predict when inventions will be made but

it is certain that a very long time will be required for the machinery to wear out. There is practically no wear except on the motor, the pump, and the milk pails and lids. Wear on the rubber tubes and most of the moving parts of the pail lids is included under repairs because most of these have been replaced at least once during the first three years of use of the machine. The Professor of Electrical Engineering in the College estimates the life of the motor under the conditions of the experimental dairy at between 35 and 40 years. The air pump should last nearly twenty years because all its working parts are continually coated with oil. The milk pails and pail lids are more apt to become obsolete by invention than to wear out in service. In fact, the pail lids have already been improved by a change in design but, through the courtesy of the manufacturer in exchanging them, no expense was incurred by the experimental dairy on account of that change. The reader will see that there is no sure way of estimating exactly the depreciation of a milking machine and motor. It is assumed here, for the purpose of figuring the cost of operation, that the life of all the machinery is twenty years, which is probably quite a little too short for the motor and pump and too long for the pails and lids. The best way of caring for the cost of depreciation is to set aside each year at interest a sum of money large enough that when the machine is completely worn out there will be enough in this sinking fund to purchase a new machine. If interest is figured at 6% and the life of the machine is twenty years, 2.7% of the first cost set aside each year will cover depreciation. Added to the 6% interest on the investment, this will make a total of 8.7% of the original investment required each year to meet interest and depreciation. On this basis, interest and depreciation are costing the experimental dairy $11.45 per year. This expense is almost constant whether the machine is used to milk only a few cows or a great many each day, the only difference being that the greater amount of use might shorten the life of the machine slightly and thus increase the depreciation charge.

Repairs for the machine during the first three years have totaled $113.61, an average of $47.87 per year. This expense would have been larger if a larger number of cows had been milked but would not have increased in direct proportion to the increase in the number of cows because the rubber parts of the machine deteriorate with age whether they are used or not. The rubber parts have been the largest single item of expense among the repairs and fifty cows could have been milked with very little more actual expense for the replacement of rubber parts than was incurred by the number of cows actually milked, which averaged about twenty-five. The other items of repair expense were new shells for the teat-cups which rusted until they were not air-tight (another effect of age rather than of use), moving parts of the pail lids, and a new belt for the motor. Since the purchase of the Station's machine, improvements have been made in the shape of teat-cup shells and in the quality of the metal used in them and in the quality of rubber used, and it is probable that repair expense for those parts will not be quite so high in the future. Other improvements may be made which will further reduce them but that is impossible to predict.

The third large expense has been for power. Electricity was used but there was no separate meter for the motor which was used on the milking machine. A total of 2109 kilowatt-hours was used during the fifteen months for which this record is available but there were from 13 to 18 40-watt lamps used for from 2½ to 5 hours each day and another one-fourth-horsepower motor was used about thirty minutes each day to turn the cream separator. Therefore, it is impossible to know exactly what proportion of this was used for the milking machine motor. However, the running time of the milking machine motor averaged 154.6 minutes per day during the eight months in which its time was recorded accurately and, if it was consuming 1.5 horsepower of electric current during the time at 70% efficiency,—a reasonable figure for that large a motor on that small a load,—it would have delivered 1.05 horsepower to the air pump, which, from the manufacturer's statements, seems to be a fair estimate. At that rate it would have used about 1000 kilowatt-hours in the course of a year. This current cost the Station 10 cents per kilowatt-hour and therefore the yearly cost for power to operate the milking machine is approximately $100.00. Probably the immediate cost of power will be less to those who use a gasoline engine but the repairs and depreciation on a gasoline engine will be greater than on an electric motor. There would be a slight saving by the use of a smaller motor because its efficiency would be higher when running at more nearly its full load. The cost of power would increase almost in exact proportion to the increase in the number of cows milked if the same number of units were used. However, if there were much of an increase in the number of cows it would be better to use additional units and the cost of power would remain almost constant, although the interest and depreciation charge would be slightly increased. The use of double units which milk two cows at once would slightly reduce the cost of power, but it would interfere with the keeping of continuous production records and therefore it has not been considered for the Station dairy although it might be good business for a commercial dairy to use both single units and double units and change them around so as to get production records of each cow only two days each week or two days every two weeks.

The only other expenses to be charged against the milking machines are a small amount of oil for the pump, the extra washing powder and soap used in cleaning the machine, and the salt and other chemicals used in the sterilizing solution in which the rubber parts are kept when not in use. These items would probably not total more than five dollars per year, and would not be much increased with an increase in the number of cows milked.

To sum up:

The total yearly expense to the experimental dairy for operation of this milking machine has been as follows:

| | |
|---|---|
| Interest and depreciation | $ 41.45 |
| Repairs | 47.87 |
| Power | 100.00 |
| Oil, soap, salt, and other chemicals | 5.00 |
| Total | $194.32 |

Just what has the Station received in return for this expense? It has been saved 2.65 minutes of man labor on every cow milked less a total of 23.7 minutes of man labor used each day in cleaning and caring for the machine. It has also been helped over periods when some of the milkers were sick or quit without warning and neither the cows nor the other milkers have been very much inconvenienced or disturbed at such times. Also the Station has been enabled to keep its laborers a longer time because continuous hand milking is more disagreeable work to most dairy laborers than operating a milking machine and stripping the cows. The first item does not of itself justify the expense with the number of cows (about twenty-five) which are usually milked at the Station dairy, but it is fairly certain that it would if the number of cows were twice as great. Also the saving of time would probably be greater with cows giving a greater volume of milk. The relation of the milking machine to the labor problem is believed to be important enough to justify it for the Station dairy, since it is especially important for cows on experiment not to be disturbed by irregular milking or milking by different milkers.

Would it pay a commercial dairy to install a milking machine? That is a question which cannot be answered for an individual dairy without knowing a great deal about that dairy, and it is for that reason that the cost of operation has been discussed above in such detail. Each dairyman can compare every item of expense with his own conditions and arrive at a surer conclusion than he could by any arbitrary rule. It will be seen, however, that two things will almost entirely decide the question. The first is the number of cows to be milked and the second is the availability of good reliable laborers for hand milking. The costs of operating a milking machine increase very little with an increase in the number of cows milked but the benefits (the time saved) increase in direct proportion to the number of cows and that is why the number of cows to be milked is such an important factor in determining the business wisdom or folly of using a milking machine. This is so important that it has given rise to the arbitrary rule often quoted that no one milking less than fifteen cows can afford to use a milking machine and very few who milk more than thirty cows can afford not to use one. While this is probably as good as an arbitrary rule can be, still there are many exceptions to it and undoubtedly some dairymen have such a large amount of desirable labor available that they can milk fifty or sixty cows cheaper by hand than by machine. Of course it would not profit a man anything to save two or three hours of man labor at milking time unless that labor could be used profitably at something else during the saved time. The use of the milking machine is purely a business proposition and should be so considered by the prospective purchaser. If he purchase one and is a good business man he will keep enough of a farm account to know the actual money cost of operation of his machine afterward and whether it is a profitable machine for him to continue to run.

## SUMMARY.

1. Machine milking followed by hand stripping probably exerts no influence whatever upon the amount of milk which a cow will give.

This experiment showed an indication of a slightly greater decrease in monthly milk production where the machine was used than were milking was done by hand but the difference was so small that it is uncertain whether the machine was the cause of it.

2. Machine-milked milk had on the average a higher bacterial count than that milked by hand. It is possible to produce certified milk with a milking machine but it requires more attention and conscientious care than to produce equally clean milk by hand. The bacterial count is a general indication of the cleanliness of the dairy in which the milk is produced but it is not an absolute measure of the healthfulness of the milk. Too much reliance should not be placed on the sterilizing power of the solution in which rubber parts are kept, lest the cleaning and scrubbing of those parts should be neglected.

3. The average time required to milk a cow by machine was 4.643 minutes and by hand was 7.296 minutes in this experiment. This difference would probably be larger with cows which were heavier producers. Care of the milking machine required an average of 23.7 minutes per day.

4. The saving in time is the only easily-measured economic benefit to be derived from the use of the milking machine. The saving in time in the milking of a small number of cows (nine in this experiment) would be required to offset the extra time used in the care of the machine. The amount of time saved is in direct proportion to the number of cows milked above this minimum number while the costs increase very slightly with increased use. This explains why milking machines are usually an economic success only where a large number of cows are milked.

5. Another economic benefit to be derived from the use of the milking machine lies in its ability to enable one or two men to milk a large number of cows in times of epidemics or other labor emergencies. This advantage is not easy to measure but would probably be most valuable on the family-size farm where dairying is carried on as the most important but not the only farm business. Large commercial dairies could probably guard against a labor shortage by other means.

6. The farm accounts of the experimental dairy for the first three years of the use of the milking machine are analyzed to show the cost of using the milking machine. The total cost was $194.32 per year, of which more than half is spent for power. Repairs constituted the second largest expense with $47.87 and interest and depreciation together make up the third which is $11.45 per year. These items are probably larger than they would be on most farms, but they will serve as a guide to the prospective purchaser in estimating costs.

7. Whether or not to use a milking machine is purely a business proposition and the answer to it will depend upon the economic conditions on each individual farm. In general it can be said that its use will pay best where a large number of cows are milked and where good hand milkers are scarce and unreliable.

8. The milking machine has another advantage, particularly in the family-size dairy, in that it makes milking a more pleasant task. However, except as this saves time and makes the laborers more contented, it does not have an easily-measured cash value.

## BIBLIOGRAPHY.

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Labor requirements of dairy farms as influenced by milking machines.
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The milking machine as a factor in dairying.
California Agricultural Experiment Station, Berkeley, California.
Bulletin No. 311 (1919)
Investigations with milking machines.
Connecticut Storrs Agricultural Experiment Station, Storrs, Connecticut.
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Illinois Agricultural Experiment Station, Urbana, Illinois.
Bulletin No. 241 (1923)
Comparative Expense of Mechanical and Hand Milking.
Kansas Agricultural Experiment Station, Manhattan, Kansas.
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Milking Machines (includes a detailed history of the development of the milking machine)
Kentucky Agricultural Experiment Station, Lexington, Kentucky.
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Michigan Agricultural Experiment Station, East Lansing, Michigan.
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Nebraska Agricultural Experiment Station, Lincoln, Nebraska.
Bulletin No. 108 (1908)
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New York Agricultural Experiment Station, Geneva, New York.
Circular No. 18 (1913)
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Circular No. 54 (1918)
Milking machines.
Bulletin No. 317 (1909)
Milking machines and clean milk.

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Machine milking does not affect milk flow.
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Milking machines.
III. As a source of bacteria in milk.
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Bulletin No. 488 (1921)
Milking machines.
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Bulletin No. 492 (1922)
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(Note. Most New York bulletins are published in two forms, a popular edition which is short and easy to read and contains all the information which would help the practical farmer, and a complete edition which includes all the details and is intended for those especially interested in that subject. A request for the bulletin should specify which edition is desired.)

Pennsylvania Agricultural Experiment Station, State College, Penna.
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TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 31 SEPTEMBER, 1923

DIVISION OF CHEMISTRY

# STANDARD FERTILIZER FORMULAS AND THEIR USE

B. YOUNGBLOOD, Director,
COLLEGE STATION, BRAZOS COUNTY, TEXAS

# STANDARD FERTILIZER FORMULAS AND THEIR USE.

G. S. Fraps, Chief, Division of Chemistry; State Chemist.

This is a statement with respect to the adoption of 11 standard formulas for mixed fertilizers, and suggestions for their use.

## STANDARD FORMULAS OF FERTILIZER.

In 1922-23, 167 different fertilizer mixtures were registered for sale in Texas. This does not include nitrate of soda, acid phosphate, or similar materials. This great number of mixtures increases the cost of plant food by increasing the manufacturers' operating expenses, and in other ways, and renders more difficult recommendation and selection of fertilizer for different uses.

At a meeting on June 28, 1923, of Fertilizer Officials, Experiment Station and Extension Service representatives, and fertilizer manufacturers and their advisers of Louisiana, Texas, and Arkansas, the following eleven formulas of mixed fertilizers were unanimously adopted for recommendation whenever possible. Their adoption does not exclude the recommendation of unmixed materials such as nitrate of soda, sulphate of ammonia, 16 per cent., 18 per cent. or 20 per cent. acid phosphate, kainit, muriate or sulphate of potash, tankage, or bone meal. Their adoption is not intended to interfere with the registration of other mixed fertilizers or the recommendation of other formulas when necessary, but preference is to be given to recommending these formulas as far as possible. It is also agreed to print these formulas as part of the name as far as practicable. The percentage of phosphoric acid is stated first, the percentage of nitrogen second, and the percentage of potash third.

These are the formulas adopted:

12-3-0, 10-4-0, 8-4-4, 7-5-5, 8-7-0, 12-2-2, 12-3-3, 12-4-4, 10-4-2, 8-4-6, 12-0-4.

It is believed that these formulas will meet practically all needs of fertilizer mixtures in Texas. Their general adoption should reduce the number of mixtures now offered for sale, simplify the recommendations of Experiment Station and Extension workers, classify the problems of fertilization to some extent, and above all reduce the cost of plant food to Texas farmers. A ton of 12-3-3 fertilizer will contain as much plant food as 1½ tons of 8-2-2, and will of course cost more per ton, but not as much as 1½ tons of 8-2-2 fertilizer, and the purchaser of a ton of 12-3-3 fertilizer will not pay for the transportation, handling, and other expenses of the extra thousand pounds included in 1½ tons of 8-2-2. This would result in the plant food costing less to the purchaser of the 12-3-3 fertilizer than to the purchaser of the 8-2-2, and plant food, not mere weight, is what is being bought in a fertilizer. All the recommended mixtures are high-grade, and their use will reduce the handling of unnecessary material to a minimum and therefore their general use will result in lower cost of plant food to Texas farmers.

### PLANT FOOD IN HIGH-GRADE FERTILIZER COSTS LESS.

Plant food costs less per pound in high-grade fertilizer than in standard-grade. A study of average selling prices in Table 1 in Fertilizer Bulletin 298 (1921-1922), shows that a pound of plant food will cost 11 per cent. more in standard-grade phosphate and nitrogen, and 13 per cent. more in standard-grade complete fertilizers, than in high-grade fertilizer.

This would mean a saving of $3.30 to $3.90 on fertilizer costing $30.00 a ton, and $4.40 to $5.20 in fertilizer costing $40.00 a ton. A ton of high-grade fertilizer costs more, but contains more value for the money.

### USE OF FERTILIZERS.

Fertilizers supply the three forms of plant food most necessary for growing crops, namely, phosphoric acid, nitrogen, and potash. For best results, other conditions should be favorable, such as a soil in good physical condition, a well prepared seed bed, good seed, good cultivation, and a good legume rotation. Nitrogen is the most expensive plant food, and for this reason the amount of fertilizers used generally does not supply all the nitrogen required by the crop. A cropping system which includes the regular growing of legumes, such as clover, cowpeas, or peanuts, to be turned under or grazed off should be followed for the purpose of securing nitrogen from the air. Such a system also adds humus to the soil, utilizes time and labor to better advantage, aids in destroying insect pests and plant diseases, and has other favorable effects.

What fertilizers to use depends upon the kind of soil, the climate, the crop, how long the soil has been in cultivation, whether or not it has grown legumes to be turned under or grazed off, what the soil will produce without fertilizer, and other conditions.

Old soils, or sandy soils generally, need more nitrogen than new soils or clay soils. Soils having a legume rotation need less nitrogen than those cropped constantly to non-legumes.

Clay soils and soils with clay or loam subsoils need little potash in Texas for ordinary farm crops, but light sandy soils with sandy subsoils may need potash. Larger amounts of fertilizer may be profitably used on crops with a high acre value, such as fruit or truck crops, than on ordinary farm crops. The fertilizer on cotton may profitably be twice as much as that used on corn.

### SUGGESTED USES OF THE FORMULAS FOR CROPS.

The following suggestions for the use of the recommended formulas in Texas were adopted at a meeting on July 25, 1923, of Agronomists of the Experiment Station and Extension Service, County Agents, the Chemist of the Experiment Station, representatives of the Agricultural press, representatives of fertilizer manufacturers, and others interested. The formula listed first is probably the one most generally needed in those parts of the State now using fertilizers largely, chiefly in East Texas. It is best for those not experienced in the use of fertilizers to begin with moderate applications and increase the quantity as experience is gained and fertilizers are found profitable.

The recommendations given below represent the best present information and will be modified from time to time, as more experimental data are accumulated, and further practical experience is secured.

### *Cotton.*

*Loam soils with clay or sandy clay subsoils,* such as Susquehanna, Lufkin, Orangeburg, or similar soils. If 200 to 400 pounds are used, 12-3-0 or 10-4-0 or 10-4-2; if over 400 pounds are to be used, 10-4-2 or 12-3-3.

*Deep sandy soil,* such as Norfolk sand. If 200 to 300 pounds are to be used, 12-2-2 or 12-3-3 or 12-4-4; if 300 to 400 pounds or more are to be used, 12-3-3 or 12-4-4 or 8-4-4. However, these are not good cotton and corn soils and are better adapted to vegetables.

*Land which produces an excessive stalk* and does not fruit well, chiefly bottom land: use 200 to 400 pounds of 18 per cent. or 16 per cent. acid phosphate.

*Black waxy land,* such as Houston black clay or other heavy black limestone soils of Central Texas. A legume rotation is needed most of all. Fertilizers are uncertain. A trial may be made of 200 to 300 pounds of 10-4-0 or 12-4-4, or 100 to 200 pounds nitrate of soda, or 100 pounds acid phosphate and 100 pounds nitrate of soda.

### *Corn.*

*Loam or Clay soils with clay or sandy clay subsoils,* such as Susquehanna, Orangeburg, or similar soils with legume rotation: use 200 to 300 pounds of 18 per cent. or 16 per cent. acid phosphate, or 200 to 300 pounds 12-3-0.

*Loam or clay soils with clay or sandy clay subsoils,* without legume rotation, in cultivation ten years or less: use 200 to 300 pounds 12-3-0 or 10-4-0 or 10-4-2.

*Loam or clay soils with clay or sandy clay subsoils, without legume* rotation, in cultivation eleven years or more: use 200 to 300 pounds 12-3-0 or 10-4-0 or 10-4-2 or 12-3-3.

*Deep sandy soil:* use 200 to 300 pounds 12-2-2 or 12-3-3. This is not a good corn soil.

*Land which produces a heavy stalk but does not fruit well:* use 200 to 400 pounds 18 per cent. or 16 per cent. acid phosphate.

*Black waxy land* (Houston black clay), or heavy limestone land of Central Texas. A legume rotation is needed first. Fertilizers are uncertain. A trial may be made of 200 pounds of 12-3-0 or 10-4-0 or 12-4-4.

### *Rice.*

*Land which produces a heavy straw,* when rice straw ashes are returned to soil: use 200 to 300 pounds acid phosphate 18 per cent. or 16 per cent.

*Land which produces heavy straw,* when rice straw ashes are wasted: use 200 to 300 pounds 12-0-4.

*Land in cultivation several years,* yields decreasing and straw short: use 150 to 250 pounds sulphate of ammonia applied when rice is half

grown or 100 to 200 pounds acid phosphate 18 per cent. or 16 per cent. applied before planting, supplemented by 150 to 250 pounds sulphate of ammonia when rice is half grown, or if rice straw ashes have been wasted, 200 to 300 pounds 12-0-4 at time of planting, supplemented by 150 to 250 pounds sulphate of ammonia when rice is half grown.

### *Alfalfa.*

*Soil recently put in alfalfa:* use 200 to 600 pounds acid phosphate.

*Soil in cultivation six years or longer* (best to rotate): use 200 to 600 pounds acid phosphate or 200 to 800 pounds 12-0-4.

*Soils poor in lime* should receive lime.

### *Tomatoes.*

*Loam soils with clay or sandy clay subsoils*, such as Susquehanna, or Orangeburg, if 300 to 500 pounds are used, 10-4-2 or 12-3-3 or 12-4-4 or 8-4-4; if 500 to 1,000 pounds, 8-4-4 or 7-5-5 or 10-4-2. Less than 500 pounds of fertilizer may be supplemented by 100 to 200 pounds nitrate of soda if there is no tendency to excessive growth of vine.

*Deep sandy soil*, such as Norfolk sand: If 200 to 500 pounds are used, 8-4-4 or 8-4-6 or if 500 to 1,000 pounds are used, 7-5-5 or 8-4-6. Less than 500 pounds of fertilizer may be supplemented by 100 to 200 pounds nitrate of soda if there is no tendency to excessive growth of vine.

*Land which produces an excessive vine:* 200 to 400 pounds acid phosphate 18 per cent. or 16 per cent.

### *Sweet Potatoes.*

*Loam or sandy loam soils with clay or sandy loam subsoils:* If 200 to 300 pounds are used, 12-3-3 or 12-3-0.

If 200 to 500 pounds are used, 12-3-3 or 8-4-4.

*Deep sandy soil:* If 200 to 300 pounds are used, 12-3-3 or 12-4-4. If over 300 pounds are used, 8-4-4 or 8-4-6.

### *Irish Potatoes.*

On loam or sandy loam soils, if 200 to 300 pounds are used, 12-3-3 or 8-4-4. If 300 to 500 pounds are used, 8-4-4 or 12-4-4 or 8-4-6.

### *Melons.*

On sandy loam soils, if 200 to 300 pounds are used, 12-3-3 or 8-4-4 or 12-3-0.

If 300 to 500 pounds are used, 8-4-4 or 7-5-5 or 8-4-6.

### *Onions.*

Use 400 to 800 pounds of 8-4-4 or 10-4-2 and supplement with one to three dressings of 100 pounds nitrate of soda or sulphate of ammonia at intervals of 10 to 15 days.

*Lettuce, Cabbage, Spinach, Carrots, and Beets.*

Apply 500 to 1,000 pounds 8-4-4 or 12-4-4 and supplement by three top dressings of 50 to 100 pounds nitrate of soda or sulphate of ammonia, ten days to two weeks apart, beginning when the plants have begun to make a good growth.

*Peach Trees.*

*Loam soils with clay or sandy clay subsoils,* such as Orangeburg, Susquehanna, or similar types: use 200 to 600 pounds per acre 10-4-0 or 10-4-2.

When in bearing, in addition, 200 pounds or more 7-5-5 or 8-4-4 increasing the quantity as the trees grow older.

*Deep sandy soil, such* as Norfolk sand: use 200 to 600 pounds 12-4-4 or 8-4-6. When the trees bear use, in addition, 200 pounds or more 7-5-5 or 8-4-6, increasing the quantity as the trees grow older.

*Sugar Cane or Ribbon Cane.*

On loam soils with clay or sandy clay foundation, use 200 to 600 pounds 10-4-0 or 12-4-4 or 8-7-0. On clay soils, bottom lands, use 200 to 600 pounds 8-7-0 or 10-4-0.

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 32 MAY, 1924

DIVISION OF ENTOMOLOGY

# COTTON BOLL WEEVIL CONTROL IN TEXAS

B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

## FOREWORD

During the thirty-two years of boll weevil infestation in Texas, the entomologists and other scientists of the A. and M. College of Texas have devoted much time and thought to the study of the boll weevil problem. One of the first workers in the field after the infestation appeared was Fred W. Mally, Professor of Entomology of this College, whose early work, particularly that relating to life history studies and the habits and peculiarities of the insect, together with his suggestions as to the value of early maturing cottons, better cultural methods and other means of lessening the boll weevil damage, have been of inestimable value to this institution and to the Texas cotton grower in shaping a policy during succeeding years for the successful combat of the weevils. It was Mally's work that encouraged the widespread use of the King variety of cotton, a very early maturing strain, in the endeavor to escape the boll weevil, and this has led the way to the development of quick maturing, but big boll cottons, much better suited to growth under boll weevil conditions than the old types grown in Texas prior to the entry of the boll weevil. Mally's work also furnished a great impetus to the demonstration work started by Dr. S. A. Knapp, particularly in its campaign for better methods of farming. Through the development of this work and similar work done by the A. and M. College of Texas, and their subsequent fusion into the Extension Service of this College, there has been a consistent and continuous campaign waged in this State for better farming methods not only for the benefits that might accrue in combating the boll weevil, but in combating other insects and plant and animal diseases. That good farming is one of the best means of combating any crop pest has been recognized and taught by this College for many years. It is the same principle followed by the medical profession in medical practice, namely, that of assisting nature to do her best to over-

come the trouble. This College has for years maintained a steadfast policy of discouraging cotton growers from attempting to combat the boll weevil by any "fly-by-night" methods. A conservative policy of combating the boll weevil, as compared with the well advertised nostrums for quickly ridding the field of this pest, is by no means spectacular; in fact, this conservative policy of the College in many instances has faded into insignificance, apparently, through exploitation and agitation of unproved means of minimizing losses. Nevertheless, these exploitations, one after another, have failed to accomplish results; whereas apparently the only consistently successful means thus far developed to curtail the work of the boll weevil has been the practice of good farming in all its phases, including cleaning up the land in the fall and eliminating the food supply of the weevils before they go into hibernation; the use of good soil preparation, good seed, and good tillage; and, in short, providing for the plant the very best natural condition in the soil for its full and complete development. We believe that such a policy will do more to maintain a normal production of cotton under boll weevil conditions than any other thing that can be done in a practical way. It is, moreover, shown in this paper that as judged from decade to decade since before the entry of the boll weevil the acre production in Texas has held fairly normal in consideration of the fact that we know that a certain amount of decline in soil fertility is actually taking place. We feel that the efforts of this College among the citizenship of this State on behalf of better farming methods have lessened the damage done by the boll weevil.

B. YOUNGBLOOD,

May 15, 1924. Director.

Circular No. 32 May, 1924

# COTTON BOLL WEEVIL CONTROL IN TEXAS

By

A. B. Conner, Vice-Director

and

H. J. Reinhard, Entomologist

## INTRODUCTORY

For thirty-two years the cotton boll weevil has made depredations upon the Texas cotton crop. Its work has resulted in the loss of millions of dollars to cotton growers. The aggregate losses amounting to such a stupendous figure have been instrumental in causing continuous agitation as to the best methods of control.

In the meantime, the entomologists and other scientists have published voluminously and completely on the boll weevil, but the very completeness of the work and the detail with which it has been presented have perhaps caused some confusion on the part of the average citizen as to what is known about the insect and effective means of controlling its work.

The recent spread of the boll weevil into the southeastern part of the United States and the passage of that section through the first throes of the attack have resulted in reviving the agitation against the boll weevil in Texas. The result has been that although this pest has been with us for more than thirty years, our people are keenly alive to its activities and are perhaps in a somewhat confused state of mind as to whether or not the measures we are using at the present time are effective ones. Part of this confusion is due to promiscuous advocating of unsound methods by those who wish to profit from the sale of improvised nostrums, machines or other get-rich-quick devices, and those with superficial knowledge of the subject who utter voluminous discussions which serve only to confuse the public. The average citizen too often feels that perhaps there is some better way of accomplishing the purpose of effective control than the methods which have been used successfully in recent years.

This state of mind on the part of the cotton growers, coupled with the fact that our acreage devoted to cotton has increased rather than decreased in every principal cotton growing region of the State, in spite of the work of the cotton boll weevil, seems to warrant the issuance of a brief, concise statement as to what is known about the boll weevil and methods of controlling its work under Texas conditions.

## HISTORY OF SPREAD

The cotton boll weevil is originally Mexican, having been found around Monclova, State of Coahuila, Mexico, where as early as 1856 to 1862 it did such damage to cotton that cotton growing there was abandoned.

In 1885, Dietz, W. G., reported the boll weevil in Texas, but this was later found to be incorrect.

In 1892 the cotton boll weevil made its appearance in the vicinity of Matamoras, Mexico, and shortly thereafter crossed the river into Texas at a point near Brownsville.

In 1894, Townsend, C. H. T., of the United States Department of Agriculture, made the first formal report of boll weevil infestation in Texas, having investigated the matter and found infestation in the region near Brownsville.

In 1894 it had spread northward from Brownsville to San Diego, Alice, Corpus Christi, Beeville, Pearsall, Sabinal and almost to San Antonio.

In 1895 it extended its range to San Antonio and eastward to Cuero, Victoria and Wharton.

In 1896 it extended northeast from San Antonio to Seguin, but made no other extensive spread that year because of severe drouth.

In 1897 it made little spread, but did considerable damage in the infested area.

In 1902 it had spread as far as Burnet, Lampasas, Bosque, Hill, Ellis, Henderson, Anderson, Trinity and Hardin Counties.

In 1903 it reached the Louisiana State line.

In 1905 it had spread northward to the Red River and eastward, infesting about one-half of the State of Louisiana.

In 1916 it had spread eastward to the Atlantic coast.

In 1919 it had reached the northern limit of the cotton belt in Oklahoma.

In 1922 it had infested practically the entire cotton growing region of the United States. The only extensive uninfested territory lies in West and Northwest Texas, this area being about the size of the State of Kansas.

Records of the infestation toward the northwest from year to year since 1910, compiled by the Bureau of Entomology of the United States Department of Agriculture, show that the boll weevil had practically reached its northwestward limit of infestation in 1910.

## HISTORY OF EFFECTS UPON COTTON PRODUCTION

According to the United States Census, Texas grew the following acreages of cotton in the years designated:

1889— 3,934,525 acres
1899— 6,960,367 acres
1909— 9,930,179 acres
1919—11,522,587 acres

The Black Lands region, the most important cotton producing region in Texas, increased its acreage during this period from 1,639,963 acres to 4,367,132 acres; West Texas from 186,497 to 1, 842,240 acres; East Texas from 1,157,499 to 2,571,808 acres; South Texas from 401,611 to 1,350,762 acres. Thus it is seen that all of the principal cotton growing sections of Texas increased in acreage by leaps and bounds, regardless of the boll weevil.

According to the United States Census, the State of Texas produced the following amounts of cotton in the years designated:

1889—1,471,242 bales
1899—2,506,212 bales
1909—2,455,174 bales
1919—2,971,757 bales

The Black Lands region increased its production from 646,198 bales to 1,094,060 bales during this period; West Texas from 75,140 to 874,882 bales; East Texas from 356,595 to 472,240 bales, and South Texas decreased its production from 168,595 to 148,652 bales during this period.

While the total production has been increased from decade to decade since 1890, the rate of increase in production has not been as great as the rate of increase in acreage.

According to the Yearbooks of the United States Department of Agriculture, showing the average yields in pounds of lint cotton to the acre for the State of Texas, it is determined from an average of five available annual yields in the decade from 1881 to 1890 that the average yield is 196.2 pounds to the acre. In the decade 1891-1900, an average of nine years shows the average yield of 194.4 pounds to the acre, while the yields for the two last decades, 1901-1910 and 1911-1920, are 161.8 and 159.4 pounds, respectively.

The effect of the boll weevil upon production is probably best shown by the figures compiled from the Yearbooks of the United States Department of Agriculture, showing the annual acreage, annual production in bales, and the average lint yield to the acre for each year for the last four decades, from which the following table has been computed:

AVERAGE ANNUAL ACREAGE, PRODUCTION AND YIELD PER ACRE FOR TEXAS

(From Yearbooks of the U. S. D. A.)

| Decade | Acreage | Production—Bales | Lint Yield Per Acre—Pounds |
|---|---|---|---|
| 1881-1890 | 3,275,951* | 1,337,543* | 196.2** |
| 1891-1900 | 6,773,858*** | 2,695,900*** | 194.4**** |
| 1901-1910 | 8,558,113 | 2,905,942 | 161.8 |
| 1911-1920 | 11,341,800 | 3,789,200 | 159.4 |

*Average of 6 years
**Average of 5 years
***Average of 7 years
****Average of 9 years

It is seen that there has been a steady increase in the acreage as judged by the average annual acreage for each decade. It is seen that there has also been a steady increase in the total number of bales produced, whereas the acre yield of lint has declined about 35 pounds in the last two decades as compared with the yield in the two first decades. It is assumed that some of this decline is chargeable to losses in soil fertility, but undoubtedly a large part of this reduction is due to the work of the boll weevil. The consistent annual yield of lint for the last two decades seems to indicate that the boll weevil damage has long since reached its maximum in Texas.

## DESCRIPTION

The boll weevil was technically named and described by Boheman, C. H., in 1843.

A revised technical description was made by Dietz, W. G., and published in July, 1891.

Subsequently, nearly every entomologist who worked with the boll weevil has given a description of the insect, so that at the present time the literature is abundant as to the description of the boll weevil.

The following is a brief popular description of the insect:

The cotton boll weevil is a winged snout beetle, averaging about $\frac{1}{4}$ inch in length. Its color is light grayish-brown to almost black, depending upon the age. Young weevils are covered with a whitish fuzz, which oftentimes wears off as the weevil grows older, exposing the darker color beneath. The snout of the weevil is nearly half as long as the body. At the end of the snout are located the "jaws", by means of which the insect is able to eat into squares and bolls. The adult weevil can be distinguished from other snout beetles by the two projections on the under side of the front legs just below the "knees." During its life cycle, three other stages are encountered, namely, the egg, which is white in color, oval-shaped, and about the size of the head

of a small pin; the larva or "worm stage" which, when fully matured, is about ½ an inch long and grayish-white in color; and the pupa or "resting stage," which is white in color and measures about ¼ inch in length.

## LIFE HISTORY

The first information relating to life history and habits of the boll weevil was published in 1894 by Townsend, C. H. T., of the United States Department of Agriculture. This work presents a brief life history of the boll weevil.

In 1901, Mally, F. W., Professor of Entomology, A. and M. College of Texas, published two reports dealing with life history and habits of the boll weevil, in which he made important contributions and added much new information to our knowledge of this insect.

Subsequently, in 1905, Hunter, W. D., and Hines, W. E., of the Bureau of Entomology, United States Department of Agriculture, published a bulletin, devoting thirty pages to the life history and habits of the boll weevil and contributing much additional information as to life history and habits of this insect.

Since 1905, additional information on the life history and habits of the boll weevil has been contributed by various parties, until at the present time we have quite complete knowledge of its life history and habits.

The life history of the boll weevil as it has been developed may be briefly stated as follows:

### The Egg

The female weevil first eats a hole into the cotton fruit and then deposits the egg in the cavity, after which the entrance is sealed by waxy material which hardens upon exposure. The egg hatches in about three to six days. On the average, the female lays more than 100 eggs during her life period. Egg-laying begins with warm weather in the spring and continues throughout the fruiting season of the plant.

### The Larva

The egg hatches into a very small worm, which soon begins to feed inside of the square or boll. It increases rapidly in size and when full grown measures about ½ inch in length. The duration of this stage varies from seven to fifteen days. The principal damage to the cotton crop is done during this stage. The injury resulting from the feeding worm causes the squares to flare, turn yellow and drop off. At this time the worm is practically matured and changes into the pupa or "resting stage" inside of the square.

### The Pupa

During this stage the insect remains inactive and does not feed. It undergoes a complete change from the worm form to the adult or weevil stage. The length of this stage varies from three to six or more days. Like the preceding stages, this one is also spent within the square and at its conclusion the pupal skin is cast off and the adult weevil eats its way out.

### The Adult

This is the active stage of the boll weevil's life, during which reproduction and migration take place. Soon after emerging the weevil begins to feed and mate and lay eggs which produce the next brood of insects. The feeding of the insect in the adult stage results in no material damage to the cotton. The average time from the egg to the weevil during the warm season varies from two to three weeks. The boll weevil hibernates or passes the winter in this stage. With the approach of cold weather in the fall the weevil becomes less active, but continues to feed and reproduce until the time of the first killing frost. About this time it begins to seek protected places in which to pass the winter. Hibernating quarters are found in trash, grass and weeds, cracks in the ground, old burrs, woods and Spanish moss, fence rows, ditches and buildings. Throughout this hibernation period the weevil requires no food. The number which die during winter is invariably more than seventy-five per cent of the total number that go into winter quarters. It has been shown that individual weevils which successfully withstand the effects of cold weather are those which emerge late in the season and have had ample food supply up to the time of hibernation. The weevils emerge from hibernation in the spring when the weather begins to warm up, but this emergence is very irregular and has been found to occur at College Station from the latter part of February until the middle of July, but for the most part during April and May.

## SOME FACTORS AFFECTING CONTROL MEASURES

Some of the factors which affect control measures may be summed up as follows:

1. The weevil depends for its life upon cotton as the source of food.
2. On emergence in the spring the weevils spread in the field by short, aimless flights.
3. They are voracious eaters in the early spring and feed readily on young cotton plants.
4. The female starts laying eggs as soon as the first squares are available.

5. The boll weevil is very prolific and by a succession of broods increases in numbers very rapidly.
6. The extent of the damage depends directly upon the number of weevils that emerge from hibernation per given unit area.
7. The number of weevils emerging from hibernation in the spring can be reduced by artificial means.
8. The matter of controlling the number of weevils emerging from hibernation for a given unit area depends directly upon controlling the number per unit area that go into hibernation in the fall and on the rate of mortality during hibernation.
9. The most vulnerable time in the life of the boll weevil is the period before hibernation.
10. The destruction of the food supply in the fall is the most important means of reducing the number of weevils per unit area that go into hibernation.
11. The effectiveness of the reduction of the numbers that go into hibernation depends upon the *early* destruction of the food supply.
12. Natural conditions oftentimes bring about the effective control of the boll weevil in Texas.

## CONTROL OF THE BOLL WEEVIL

The control of the boll weevil may be divided into two general classes: natural and artificial.

### Natural Agencies of Control

Under Texas conditions the natural agencies of control are by far the most important and the most effective of all agencies of control. Dry weather and low humidity are known to be unfavorable to the development of the boll weevil. Hot sunshine with high temperature kills many of the developing larvae in the fallen squares. High altitude and the consequent general low humidity during the growing period coupled with the more severe winter weather are effective in checking the injury, and reproduction of the insect. In fact, in part of the cotton growing region of Texas these conditions have prevented the weevil from becoming established. The prairie regions not only afford unfavorable hibernating quarters for the boll weevil, but the soils of these areas are for the most part uniformly fertile and provide conditions conducive to early and uniformly rapid heavy fruiting of the cotton plants, a condition which allows the weevil a very short period of time to cause extensive damage to the crop. Texas has large areas of good cotton land subjected to one or

more of these conditions and consequently is naturally situated so as to benefit greatly from natural agencies of control.

While man can exert no influence over these natural agencies of control, he can and should recognize the geographic location of his farm with respect to these natural facilities for control.

### Artificial Means of Control

It should be recognized that artificial means of control are secondary and of supplemental value to the natural agencies of control. The principal artifical measures embrace:

1. Means of reducing the number of emerged weevils and their progeny.
2. Means of reducing the number of weevils that go into hibernation in the fall.
3. Means of providing the best growing conditions for the cotton plant.

*Means of Reducing the Number of Emerged Weevils and Their Progeny:*

The principal means by which the reduction of the number of emerged weevils may be accomplished is by the use of poisons. Other means of combat, such as the use of catching devices, the picking up of squares and other devices and practices of this nature have not been effective in Texas.

While poisoning has shown good results under certain conditions, it is not at the present time extensively practiced in this State. The best poisons to use are calcium arsenate and lead arsenate. When poisoning is resorted to the poison should be applied as a dust with machines designed for the purpose. From five to seven pounds to the acre is required for a single application. If poisoning is to be done it should be started before the infestation has reached 10%, which can be determined by counting the number of punctured forms and the total number of forms on a given area, and dividing the former by the latter. Such counts in different parts of the field will give an average per cent of infestation. Poisoning is a complicated process involving heavy expense for machinery and poisons, and should be resorted to with caution. The profitable use of poisons can be practically nullified by the presence of exceedingly favorable natural conditions for the development of the boll weevil. On the other hand, the use of poisons may be unnecessary and without value under natural conditions unfavorable to the boll weevil and which oftentimes effectively control its work. It is certain that poisoning will not be uniformly effective with surety over any extended region or on a given field from season to season and hence the use of poison cannot be recommended as a general practice, but must

be applied in individual cases based upon individual judgment in each case. Any means of combating the boll weevil during the fruiting period of the cotton plant by direct measures is uncertain of results and should not be depended upon exclusively by farmers.

*The Reduction of the Food Supply*:

The early destruction of cotton plants, the food supply of the boll weevil, prior to the end of the growing season is disastrous to the boll weevil. It is a practice which, if done by a whole community or a section, will with certainty be effective. It is not so susceptible to fluctuations in effectiveness as some other means and, therefore, it can be safely and generally used with good results.

In a large part of Texas the cotton crop is harvested sufficiently early to enable the farmer to destroy cotton stalks a considerable time before frost. The destruction of cotton stalks before the hibernation time of the weevil cuts off the food supply of the insect at a time when it needs food to prepare for successful wintering. Accordingly, the earlier this food supply can be destroyed the more effective will be the results. The food supply, moreover, should be destroyed over as large areas as possible and can best be done through concerted action of communities. The expectation of a top crop has done more to hold back the destruction of cotton stalks in the fall than any other one thing. It is well known that top crops under boll weevil conditions are of little or no value, and no farmer should delay plowing up cotton stalks after the main crop is harvested with the expectation of getting a late crop in spite of the weevil. Any method used in killing cotton stalks should be thorough.

*Means of Providing Best Conditions for Fruiting*:

The practice of good farming will promote the best growing conditions for the cotton plant. It is imperative that the cotton plant fruit heavily if good yields are to be expected under boll weevil conditions, for without heavy fruiting the boll weevil will take a proportionately heavier toll and thus lower the net amount of cotton produced by the farmer. Just what constitutes good farming and good conditions for heavy fruiting of cotton is pretty well understood by every cotton grower. Every effort should be made to build up and maintain soil fertility, to prepare the land early and in such a way as to conserve an abundance of moisture and to develop an abundance of plant food for the use of the cotton plant. Good seed of one of the standard varieties adapted to the locality should be used. Cotton should be planted early. A good stand is necessary. Fertilizer should be used where necessary. The cotton should be planted clean and the

cotton crop kept free from weeds, which use up moisture and plant food. Any farmer who is in doubt about fertilizer requirements of his soil and other details can consult his County Agent or other authorities of the A. and M. College.

Summing up the methods of procedure, effective measures of control may be stated as follows:

1. Every effort should be made to destroy cotton plants, the food supply of the boll weevil, in the fall as soon as the cotton crop is harvested.
2. The use of poisons should be resorted to in individual cases where the cotton is fruiting heavily and where the prospects favor severe infestation.
3. Good farming should be practiced to insure heavy fruiting of the plant and consequently produce profitable yields even under boll weevil conditions.

Finally, the whole question of boll weevil control resolves itself into one of good farming.

TEXAS AGRICULTURAL EXPERIMENT STATION
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
W. B. BIZZELL, President

CIRCULAR NO. 33 May, 1924

# TEXAS AGRICULTURAL EXPERIMENT STATION SYSTEM

B. YOUNGBLOOD, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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CIRCULAR NO. 33 MAY, 1924

# TEXAS AGRICULTURAL EXPERIMENT STATION SYSTEM

B. Youngblood, Director

*Purpose:*

Every man born into the world is confronted on the one hand by opportunities and on the other hand by obstacles. Man progresses only by availing himself of his opportunities, which are increased in number and importance only by his overcoming his obstacles. The sciences, and accompanying scientific methods, are the chief means whereby man overcomes his obstacles. In the laboratory we recognize the obstacles in the way of man's welfare as problems to be solved by the sciences through the employment of scientific methods. Research, therefore, is the systematic study of problems. The ultimate objective of research is new and additional knowledge.

*Function:*

It is the business of any research agency to carefully project its work, employ suitable methods, accurately record and interpret the facts at hand, and possibly also to suggest practical applications of any knowledge thus gained. Actual knowledge, not vague theories or mere observations, is the only sound means of overcoming the obstacles in the way of our State and National welfare.

The farmers and the stockmen are confronted with a multitude of obstacles which become the problems of the agricultural scientists in this and other states. The public recognizes that it is to the benefit of all society for the farmers' and the stockmen's problems to be solved at public expense, partly because of the inability of the farmers and the stockmen to solve these problems themselves, and partly because of the great expense involved. The Texas Agricultural Experiment Station System recognizes its function and its duty to make applications of the several sciences to the problems of agriculture, through the use of appropriate methods, with a view to the development of information which may be put into harness on Texas farms and ranches to the end that suitable progress in agricultural industry may be realized.

This knowledge is needed in Texas, not only in order that farmers may farm better, but that the children of the State may be more completely educated with reference to the agricultural industry, and that people engaged in agricultural pursuits may live more fully and develop into a higher type of citizenship. Obviously such information made available to agricultural people simultaneously becomes available to the entire citizenship, enables the men of the city to appreciate the importance of agriculture to other industries, and possibly to become more considerate of the farmers' and the stockmen's problems than otherwise would be the case.

*Scientific Methods:*

In the beginning, we wish to make it perfectly clear that the scientific methods of research are employed in the assembling and the interpretation of facts. The methods used by the several specialists in charge of projects are those official methods which have the most general recognition of the scientific societies to which the specialists belong. No work is permitted anywhere within the Station System except that which is projected in accordance with the methods of scientific workers, and in connection with such projects the scientific methods to be employed are always included as necessary parts of the project outlines.

*Organization:*

The Texas Agricultural Experiment Station System is organized into a Main Station and fourteen subordinate field laboratories or substations. There are fourteen research divisions of work in the Main Station at College Station, and fourteen outlying experiment farms, known as substations, located in as many representative agricultural regions of the State, and in addition there are four field laboratories, or outyards as they are termed, devoted to beekeeping investigations. These divisions, substations, and outyards are as follows:

1. Administration
2. Veterinary Science
3. Chemistry
4. Horticulture
5. Animal Industry
6. Entomology
7. Agronomy
8. Plant Pathology and Physiology
9. Farm and Ranch Economics
10. Soil Survey
11. Botany
12. Publications
13. Feed Control Service
14. Main Station Farm
15. Substation No. 1, Beeville, Bee County
16. Substation No. 2, Troup, Smith County
17. Substation No. 3, Angleton, Brazoria County
18. Substation No. 4, Beaumont, Jefferson County
19. Substation No. 5, Temple, Bell County
20. Substation No. 6, Denton, Denton County
21. Substation No. 7, Spur, Dickens County
22. Substation No. 8, Lubbock, Lubbock County
23. Substation No. 9, Balmorhea, Reeves County
24. Substation No. 10, College Station, Brazos County
25. Substation No. 11, Nacogdoces, Nacogdoches County

26. Substation No. 12, Chillicothe, Hardeman County
27. Substation No. 14, Sonora, Sutton-Edwards Counties
28. Substation No. 15, Llano Grande, Hidalgo County
29. State Apicultural Research Laboratory, San Antonio, Bexar County
30. Research Queen-Yard, San Antonio, Bexar County
31. Research Bee Outyard, Dilley, Frio County
32. Research Bee Outyard, Roxton, Lamar County

*Relation of Organization to Size of State and Diversity of Conditions:*

The State of Texas, with an area of 265,896 square miles, nas fourteen experiment farms or substations, while the State of Wisconsin, with an area of 56,066 square miles, supports seven outlying stations. On an equal basis of service per unit of area, Texas would require 33 outlying stations. On the other hand, it may be stated in fairness that, as a rule, the agricultural regions of Texas are larger than those of Wisconsin, or perhaps of many other states. It should be stated, however, that certain well defined agricultural regions in Texas are as yet inadequately supplied with research facilities. This is due in part to the wide range of climatic conditions and the variety of soils and soil conditions and in general to the fact that the size of the State has caused the Station System to be able, so far, to consider only the most pressing of our agricultural problems.

*Historical Development of Agricultural Research in Texas:*

The first official agency for agricultural research in this State dates from the organization of the Texas Agricultural Experiment Station, under the provisions of the Federal Hatch Act, on January 25, 1888. For many years after the organization of the Station, the work was done under a policy of having the investigations conducted by teachers and other employees of the College. Major L. L. McInnis, now residing in Bryan, Texas, who was Chairman of the Faculty of the College when the Station was organized, states that this mixing of salaries and duties was due to the inadequacy of funds for either teaching or research. Accordingly, those who were doing the teaching were assigned research titles and salaries. Thus the Station ran from 1888 until about 1909 with a surprisingly small amount of real scientific work accomplished under this system. The bulletins, financial reports, and old inventories of the Station, still on file, will indicate whether or not the system was a scientific success. In 1906 the Federal Adams fund became available, providing for purely original reasearch. This act carried rather strenuous provisions against the misuse of the fund and the money was under direct Federal supervision. This, together with the previous history of the Station, brought forward discussions of organization in reference to efficiency and resulted in a provision for definite differentiation in 1906. This policy, however, was changed very gradually through a period extending from that date to about 1918, so that no great inconvenience would be experienced by either

teaching or research. In the meantime, methods of correlation and of cooperation between teachers and research workers were being developed, so that in the long-run there was no material difference as to the number of men employed wholly or in part in teaching or in research in this institution and others in its class.

For the twelve years, 1911 to 1924, during which the present policy has been followed, the Station has issued a total of 227 official publications, or 74 more than were issued during the entire 23 years of the Station's existence under the former policy of having teachers and other employees conduct the research. An examination of these publications, which are now on file in our administrative offices, in the libraries, and elsewhere, will show conclusively that the character and the quality of the research publications issued by the Station System have materially improved during this period. Attention is called to the fact that many of the first 150 publications issued were either compilations or bulletins based upon very elementary, if any research. Since 1911, practically every bulletin issued has been based upon separately planned and performed experiments, investigations, or researches, while bulletins and circulars of a popular nature have been prepared and issued by the Extension Service of the institution. It is natural, of course, to presume that the advancement and perfection of methods and the general improvement of research activities would tend to raise the quality of publications issued during the latter period, but the outstanding facts are that the Station's organization devoted its major energies to research and vastly increased its efficiency as measured in terms of results. During this twelve-year period, many valuable contributions to knowledge have been made, in addition to the regularly printed bulletins, reports, and circulars of the Station System, in the publication of approximately 230 research papers in scientific journals, of which 29 have been submitted by members of the Station Shystem's staff during the past year. Papers so published represent, as a rule, the highest type of research among scientific men. They not only present the findings of the several types of scientists by the application of scientific methods, but also the development of scientific methods themselves. The staff of the Station System has done its full share of the work of the scientists of this country in contributing to the development and refinement of scientific methods employed in scientific research. These articles were published in such periodicals as the Journal of the American Society of Agronomy, the Journal of Genetics, Science, the Journal of Agricultural Research, the Journal of Heredity, and other periodicals of local and national importance.

*Types of Service Rendered by the Station System:*

Some examples of the service rendered by the Station System as a research agency may be enumerated as follows:

The dissemination of principles which are useful to farmers and stockmen, and valuable for the development of the agricultural resources

of Texas. Examples of the service rendered by the dissemination of principles based upon research are those concerning the economic operation of ranches and ranch lands, of special significance in Texas inasmuch as 73 per cent. of the total landed area of the State is grazed; those underlying the production of cotton in the semi-humid region of the State, in which is situated the 29 per cent. of the landed area of the State now free from the boll weevil. A large part of this region is well adapted to cotton production, and it is the only region of any great extent lying within what may be said to be the cotton-producing region of the United States which may now be considered free from the boll weevil. The development of the principles underlying the production of cotton in this region, therefore, is an outstanding contribution, not only to the resources and wealth of the region itself, but also the resources and wealth of the entire State.

Other examples are the improvement of wool and mohair production in flocks of sheep and Angora goats based upon studies of the weights of fleeces and other hereditary characters in relation to environment; identifying one cause of the spread and developing measures for the control of cotton root rot, a disease which is causing an annual loss conservatively estimated at not less than fifteen million dollars which must be borne by the cotton growers of Texas. This contribution which, for the first time on record, sets forth one of the principal means whereby this disease and methods by which its spread may be retarded, will be of great value in the ultimate control of this disease of cotton. Still more examples are the development of principles relating to the differences in ability to germinate of different lots of cotton seed, under unfavorable conditions, and tending toward the ultimate development of hardier strains possessing unusual seedling vigor for use under the erratic climatic conditions so common in the State. This single accomplishment is of value not only to the breeders and growers, but also to agencies in charge of regulating the sale of cotton seed. Further, the development and dissemination of principles concerning the feeding values of plants and plant products, and in relation to the utilization of these products as feeding stuffs, have been the basis of regulatory work in connection with the administering of the pure feed law. There are numbers of other examples set forth in the publications of the Station System.

Service to farmers and to agriculture in general by the dissemination of newly introduced or newly developed strains of plants and animals are numerous. Specific examples of service of this nature are the introduction into Texas in 1909 of Sudan grass, the value of the crop of which in the United States now amounts to fifteen million dollars; the introduction in 1909 of feterita, a crop which has been a valuable addition to the grain sorghums the annual yield of which in Texas now amounts to more than forty million bushels; the development and distribution of Spur feterita in 1918, a superior selection of feterita which has now practically replaced the common strains in Texas; the development and distribution of Blackhul Kafir 153 in 1920; the development of the Nessberry, a valuable hy-

brid of dewberry and raspberry; the development of an unusually high-yielding peanut at Nacogdoches; the introduction and propagation of the Chinese elm which has proved to be a valuable tree for a large portion of the State; the introduction and propagation of the Arizona cypress, a valuable tree for West and Northwest Texas; the development of a pedigreed strain of White Leghorn chickens based upon the actual results of high egg production; the distribution of pedigreed queen bees, and numerous other cases that might be mentioned.

*Contribution to the Store of Agricultural Knowledge:*

The research agency is a large contributor to the store of agricultural knowledge used in the classroom and disseminated to the people through the teaching and extension branches of the institution. General principles developed from bodies of facts are useful, but the chief store of agricultural knowledge comes from the publication of detailed data concerning certain points and establishing certain facts with scientific accuracy, all of which are subsequently included in textbooks as the basis of instruction in education in agriculture.

On account of the size of the State and the diversity of climatic and soil conditions in Texas, there is urgent need of agricultural information applicable to local conditions, and that this information is being developed and given to the citizens of the State is indicated by the 380 publications which have been issued by the Station System since its organization in 1888.

*Relation of Research to Teaching and Extension:*

Any truly efficient and serviceable institution develops its organization and policy out of a multitude of forces, related and unrelated. The organization of this institution has arisen out of the harmonizing of certain ideas pertaining to extension, teaching, and research, as they must exist in the State of Texas rather than in some other state. It is believed, for example, that research is fundamental to progress, and, therefore, that research must be prosecuted in an effective manner. For the dissemination of the knowledge gained by research there must be teaching, both within the walls of the College and without. Teachers, too, must be efficient, and when they go before students beyond the sophomore year they should be of the research type of mind. Such students should come rather to serve an apprenticeship under the professor than to be instructed and disciplined by him. Teachers of this character, therefore, must be permitted to do some research, presuming, of course, that they are qualified. Moreover, it is believed that it is well for the research man to explain his findings and otherwise to express himself before the public groups, not only to adults within his science, but without, and also to students, graduate and undergraduate.

In this utilitarian world, wherein science is the epitome of efficiency, we are called upon to do everything possible for feeding and clothing an ever-increasing population with an ever-increasing standard of

living. With the area of the earth remaining the same, nothing must be left unturned to bring about efficiency in the productive processes. The idea of the division of labor so clearly presented by Adam Smith, to which we attribute the Industrial Revolution, has become so far perfected that we have not only a division of labor, but a vast differentation into subdivisions, far greater than Adam Smith could ever have conceived. Those whose duty it is to make research function in such a world, therefore, feel that they must not be divested of their right to employ the division of labor in the development of efficient research machinery for the State. Yet it is known to publicists that along with the division of labor there must come an ever-increasing amount of cooperation among those engaged in the different divisions of effort.

It would seem, therefore, that any organization which assures an appropriate division of labor and at the same time brings about a satisfactory cooperation and correlation among the different types of specialists would prove to be a truly efficient agricultural college.

In accordance with these ideas, in this institution we have an Agricultural Experiment Station System with a staff of specialists whose major responsibility is the successful prosecution of agricultural research. These men are paid entirely out of research funds. Likewise, there is a teaching staff, or faculty, paid out of teaching funds, whose chief duty is teaching, and, again, there is an extension staff, paid exclusively out of Extension funds. This is reasonable specialization in the division of labor. In order, however, that no talent may be lost, there exists in this institution an arrangement whereby a research man may do a limited amount of teaching and extension work, and a teacher is allowed to carry a limited amount of research and extension duties. Since the establishment of the policy of specialization in the institution, a memorandum of agreement has been entered into by the School of Agriculture and the Agricultural Experiment Station System whereby all teachers in the School of Agriculture, who are in position to conduct investigations, are urged to do so. All they have to do is to prepare a project, which, if properly drawn, will be approved by the Director. Thereafter they have their own freedom in the matter of pursuing the study until interesting results may be secured. In return for the research services thus rendered by the teachers, the Dean of the School of Agriculture may call upon the research staff to do whatever amount of teaching may be consistent with the primary duties of the research workers. In accordance with this memorandum, there are nine teachers in the School of Agriculture who are carrying research projects on the Station System, and there is hardly a member of the research staff, from the Director down, who does not do a limited amount of teaching, either regular or irregular, during a year. There are some men on the research staff, of course, whose duties are such as to preclude the possibility of their doing any teaching, but there are few such men in this institution.

This formal memorandum of understanding between the School of

Agriculture and the Agricultural Experiment Station System was signed up on February 25, 1914, and amended in 1919, and revised and resigned on May 21, 1923. A copy of the memorandum follows:

"Memorandum of Understanding
between
E. J. KYLE
Dean, School of Agriculture
and
Dr. B. YOUNGBLOOD
Director, Experiment Station

Agricultural and Mechanical College of Texas

The object of this memorandum of understanding is to provide for cooperation between the School of Agriculture and the Experiment Station in all instances wherein cooperative effort is mutually advantageous.

It is mutually understood that the work of the Agricultural and Mechanical College of Texas comprises five major divisions of effort. They are:

1. School of Agriculture
2. Experiment Station
3. Extension Service
4. School of Engineering
5. School of Veterinary Medicine.

Divisions 3, 4, and 5, are not to be considered in this memorandum of understanding.

It is understood:

(a) That the chief function of the School of Agriculture is resident teaching, and

(b) That the chief function of the Experiment Station is to conduct tests, experiments, investigations, and researches in agriculture and to provide for the dissemination of the resulting information.

It is also understood that in all efficient agricultural colleges there is a definite relation of investigation to teaching work; that wherever there is found a weak experiment station there is also found a correspondingly weak agricultural school. On the other hand, wherever there is found a well-developed experiment station there is also found a first-class agricultural school. This is the case in Illinois, Wisconsin, Ohio, New York, and Missouri.

The main object, therefore, of this memorandum of understanding is to develop both Station and College together in such relation as will make this institution most efficient in serving the agricultural interests of Texas and in becoming one of the leading agricultural colleges of the United States.

It is further understood that the time has arrived in the history of this institution when a man should be assigned primarily either to investigation, to teaching, or to extension work, and when once assigned to[1] Station work he should be required to perform only such lecture or extension work as will not interfere with his duties as an investigator in the least. Or when a man once is assigned to teaching, he should be required to perform only such station or extension work as will not interfere in the least with his teaching duties.

There are many instances wherein opportunities for cooperation may arise; not to the detriment, but to the mutual advantage of the cooperating agencies; some of which are:

1. In order to familiarize agricultural students from year to year with the work of the Experiment Station, a short series of lectures, say, three, six, or nine, during a scholastic year, might be delivered to students of the School of Agriculture by members of the Station Staff. In certain cases where a certain member of the station staff is especially well qualified on a particular subject, arrangement may be made to have him deliver a series of lectures extending throughout a full semester. These lectures are to be arranged jointly by the heads of departments in the School of Agriculture and the heads of the corresponding divisions of the Experiment Station. As soon as arranged by these officials, a schedule comprising all lectures to be delivered by the Station Staff shall be prepared and presented to the Dean of the School of Agriculture and the Director of the Experiment Station, for joint approval; this schedule to be prepared as near as possible at the beginning of the scholastic year.

2. In order that the professors, associates, assistants, and instructors may themselves keep in touch with the Station work, specific projects of investigation may be assigned to such of these men as are imbued with the spirit of investigation and whose training and experience may indicate their fitness for conducting such work.

[1]Proceedings, American Association of Agricultural Colleges and Experiment Stations, and statements by its President, Dr. A. C. True, Washington, D. C.

It is understood that projects coming under this memorandum of understanding are not to be duplicative of any regular experiment station projects alread assigned. Nothing in this memorandum, however, shall be construed as precluding the planning and ultimate approval of cooperative projects in cases where a college and an experimet station man are mutally interested in a given study.

It is further understood that all projects are to be arranged for jointly by the heads of departments in the School of Agriculture and the heads of divisions of the Experiment Station. After projects are thus agreed upon they shall be presented in written form, in the same manner as are Expriment Station projects, to the Dean of the School of Agriculture and the Director of the Experiment Station, for joint approval. One copy of each project must be filed with the Director of the Experiment Station, one copy with the head of the division of the Experiment Station concerned, and one copy with the Dean of the School of Agriculture.

These investigations coming under this understanding shall be conducted as projects of the division of the Station interested.

Whenever investigations coming under this understanding shall result in any information of sufficient importance to the agriculture of the State, the Director of the Experiment Station will consider it for publication, the same as he does data resulting from the regular investigations of the Station, and when manuscript is presented in proper form, will publish it either as an Experiment Station bulletin or circular, depending upon the nature of its content, in accordance with the policies of the Station relative to publications.

The following is an outline of the course that a project shall pursue from its initiation to its conclusion:

1. Project number (to be assigned by the Director)
2. Name of project (specific, not general).
3. Leader (do not name helpers as leaders, but indicate how many helpers there will be, and who they are)
4. Headquarters (College Station, Texas)
5. Date suggested
6. Date authorized (by the Director)
7. Date begun
8. By what authority
9. Object (stated briefly and clearly)
10. Method of procedure (outline briefly the problem to be investigated and the method of investigating it. Before writing this, however, all available authorities upon the subject shall be consulted)
11. Contracts or agreements (attach copies or state briefly)
12. Source of maintenance (give amounts available from each source)
13. History
14. Annual records of progress
15. Projected publications.
16. Publications issued
17. Costs; including (a) salaries; (b) traveling expenses; (c) others.

All projects to be numbered and listed by the Director of the Experiment Station.

This outline may be modified as necessary for a given project by joint action of the parties to this memorandum of understanding.

3. In order to maintain the proper ratio of development between the School of Agriculture and the Experiment Station, the Dean and the Director may cooperate in the preparation of biennial statements before submitting them to the President.

4. In addition to the lectures provided for in Section 1 of this memorandum of understanding, students may be invited by the Director or the head of a station division to make use of the Experiment Station library, and to visit Station laboratories and fields for practice. It is understood, however, that Station laboratories and fields shall not be used for instructional purposes until the heads of Station divisions and teaching departments jointly arrange for such visits. Instances wherein Station fields may be used to advantage are the Experiment Farm for observations on plat work, and the feeding and breeding farm for stock judging, and observations upon feeding and breeding experiments, silage production, the erection of silos, and so forth.

5. The Dean of the School of Agriculture may be of great service to the Experiment Station in assisting the Director in the selection of capable young men out of each year's senior class for positions as scientific assistant in the various Main Station divisions and on the several substation farms. It is further understood that the Experiment Station employs these young graduates not so much for their immediate services as for their further training and development along the line in which they are chiefly interested. It is better both for the institution and the individual, in the long run, for the Station to test out these young men before launching them upon their career than it is to launch them as soon as graduated. In other professions an apprenticeship is served under a competent leader before the apprentice assumes leadership himself. This is equally as desirable in agriculture as in other professions.

It is understood that this memorandum of understanding may be modified from time to time by joint action of the Dean of the School of Agriculture and the Director of the Experiment Station, as the exigencies of School or Station work may warrant.

Dated at College Station, Texas, the 25th day of February, A. D., 1924. Revised 1919; revised 1923.

Signed in triplicate. One copy to each of the contracting parties and one copy to the President of the College.

The School of Agriculture
By E. J. Kyle,
Dean.

The Experiment Station
By B. Youngblood,
Director.

APPROVED: May 21, 1923.
W. B. Bizzell, President.
Agricultural and Mechanical
College of Texas."

In the manner indicated, all the available man-power of the entire institution is focused on research on the one hand, and the research contributes to the effectiveness of the teaching on the other. Teachers engage in research because of their love for the work rather than for the purpose of securing additional salary as is commonly the case in many other institutions.

Our experience here convinces us that the maintenance of a research staff, paid and held responsible chiefly for research, speeds up this work in a manner such as no other system has ever accomplished at this institution. Efficiency is effected by the division of labor and correlation is brought about through an institutional organization specially designated for the purpose. All problems pertaining to an appropriate correlation of teaching, extension, and research are handled by an Administrative Council, consisting of the President, the Deans, and the Directors. During the twelve years of the history of this organization, no institution in this country can boast either of greater advancement in usefulness or harmony among staff members.

*Relation to Present and Future Agricultural Development:*

The possibilities of the Agricultural Experiment Station System for usefulness in the development of the agriculture of this State may be indicated by enumerating briefly some of the things already accomplished by the Station, and then a few of the more urgent problems, yet to be solved, confronting our agriculture at this time.

*Some Accomplishments:*

1. Developed an Experiment Station System on a scale large enough to take care of the major agricultural problems of the State. This includes the establishment and operation of substations in different parts of the State, so that the various problems of the several agricultural regions of the State might be studied with all the efficiency of the Main Station, and further the development and expansion of the Main Station itself.
2. Developed the Texas Fever immunization process, by which the Station has immunized more than three thousand bulls imported for the improvement of Texas herds. This process revolu-

tionized the cattle industry throughout the tick infested regions of the world.

3. Effectually administered the pure feed law of Texas, with the result that we have the highest quality of feeding stuffs of any state in the Union or country in the world. Our administering of this law has, through its high standards, served as a protection of the people of the State against adulteration of feeding stuffs by unscrupulous manufacturers or dealers, and by reason of the high quality of products available the cream of the world's trade in cottonseed meal has been brought to Texas.
4. Developed and introduced the leading strains of grain sorghums now commonly grown in West Texas, the annual yield of which amounts to more than forty million bushels in Texas. The problem in this case was to develop a grain crop that would take the place of Indian corn under semi-arid conditions where the corn crop is unsuccessful.
5. Developed the fact that cotton is a drouth-resistant crop adapted to semi-humid and semi-arid conditions, with the result that a large territory in Northwest Texas, not infested by the boll weevil, has been brought into cotton growing.
6. Introduced Sudan grass into the State and promoted its development to the point that it is now one of the most widely grown and known hay crops in the State.
7. Introduced alfalfa into Northwest Texas.
8. Introduced plants, including not only field crops, but also fruits, vegetables, and ornamentals from practically every state in the Union and from foreign countries, through cooperative work with the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture.
9. Determined proper crop rotations and fertilizer practices for practically every section of the State.
10. Determined, by digestive experiments, the feeding values of the principal feeding stuffs grown in Texas.
11. Made, in cooperation with the Bureau of Soils of the United States Department of Agriculture, detailed soil surveys of 57 counties and areas, and reconnoissance soil surveys of 134 counties in the State.
12. Determined the cause of pink root of onions, a disease which has caused serious losses to onion growers of the State, and developed methods of its control.
13. Developed scientific studies of ranching in Western Texas which tend to put the industry on a new basis of efficiency.
14. Established and operated a wool and mohair scouring and grad-

ing plant, which has been of vast service to the Angora goat and sheep industries of Texas, by enabling the growers to perfect their breeding and to secure better prices for their wool and mohair.

*Some Urgent Problems:*

1. To find possible means of spread of cotton root rot other than by root contact, looking toward the formulation of effective methods of controlling the disease.
2. To determine the cause of loin disease of cattle and the relation, if any, of this cause to mineral deficiencies, looking toward the elimination of losses from this disease.
3. To determine the carrying capacity of the ranges.
4. To study and analyze the botany of the ranges.
5. Study the diseases of range animals.
6. Make studies of managerial ability and range problems.
7. The study of inheritance of characters in cotton, with the view of enabling breeders to more effectively combine the desirable characters in the improvement of cotton, our most valuable crop.
8. The completion of detailed soil surveys for all counties in the State, in order to provide an inventory of the types and classes of soils as related to agriculture.
9. The cause and methods of control of swellhead of sheep and goats, a fatal disease which causes heavy losses in Southwest Texas, the region in which one-fourth of the Angora goats of the Nation are grown.
10. The fixing of the type of the Angora goat, and the improvement of sheep by breeding methods.
11. Studies leading to the rehabilitation of the peach industry in East Texas.
12. Developing rust-resistant strains of winter wheat.
13. The inheritance of characters in grain sorghums.
14. Development of superior strains of rice and efficient methods of producing rice.
15. The composition of Texas soils and the availability of their plant foods.
16. The development of specialized and highly renumerative crops for growing in irrigated sections.
17. Determining a suitable system of intensive farming for the Central Gulf Coastal Plain.
18. Citrus fruits and vegetable studies, looking to the development of these industries in the Lower Rio Grande Valley.
19. Studies of the most effective and the most profitable means of building up and maintaining the fertility of the soils of East Texas.

20. The economic production and marketing of farm and ranch products in the different agricultural regions of the State.
21. Crop adaptation and crop utilization in the different agricultural regions of the State.
22. Animal nutrition studies.

*Business System and Business Methods:*

All of the fiscal business of the Station System is handled in the following manner:

1. The funds are apportioned or allotted.
2. No expenditure is made without a requisition or letter of authorization approved by the Director.
3. All official payments are made upon vouchers, bearing affidavits, executed as the original bills.
4. Vouchers are supported by subvouchers (receipts) where incidental expenses are incurred; these subvouchers are attached to the vouchers which are submitted to the State Comptroller for final payment.
5. The Chief Clerk and all superintendents of substations or other officers handling funds and property are under appropriate indemnity bonds.
6. The official accounts are audited annually, and the annual inventories, required for all properties, are checked each year, by Certified Public Accountants employed by the Board of Directors.
7. No travel is performed without securing written authority, definitely stating the purpose of such travel, in advance.
8. There is a certain amount of freedom in the purchase of scientific apparatus and other specialized equipment required for research, which allows a freedom of action on the part of the investigators. This freedom of action is sometimes very essential to the proper conduct of the work.
9. Alloted funds are carefully checked from time to time to prevent the possibility of overrun in any item of account.
10. No deficiencies are ever created.

The relation of the business system and business methods employed to the public policy, is that public funds are safeguarded from over-expenditure, extravagance, and waste, without unnecessary red-tape or loss of time.

All products or property sold are receipted for in triplicate, the original receipt (numbered and recorded) going to the purchaser, the duplicate being transmitted to the central office with the proceeds, and the triplicate is retained by the seller, so that there is an absolute check on anything sold and on all funds received by officers and employees.

Every cent of money received from the sale of products or material of any nature is placed in the treasury and requisitioned and vouchered in identically the same manner as State or Federal funds.

*Present Administrative Policy and its Relation to Economy:*

The question of administrative policy with reference to research is one of great importance in economy and efficiency in the expenditure of funds. Efficiency in a research institution relates to the efficiency of the organization in turning out results which are accurate and worth-while.

In the conduct of the business of a research organization there arises the problem of the sale of by-products, and, as in the case of the sale of products of any kind or character, it is often necessary to expend both time and money in preparing these products for market. Accordingly, in the administration of a research institution, there is a possibility of letting the sale of by-products handicap the operation of the unit. The policy of the Texas Agricultural Experiment Station System is to sell its by-products and, in accordance with the provisions of the law, turn the money thus received back into the research work, to be expended upon requisition and voucher, exactly like appropriated funds.

When the sales fund of the Station System was, according to law, turned into the State Treasury there was very little revenue thus derived by the State, because there was no incentive on the part of the workers to create a larger sales fund. In fact, they could not do so without the loss of the appropriated funds which went into the creation of the products sold. In 1911-1912 the total sales fund of the Station, turned in to the State Treasury, amounted to $1,106.17. For the fiscal year ended August 31, 1913, when the law was changed and the Station System was allowed to receive back and use the sales fund as a revolving fund, the same men and the same properties turned in total sales fund to the amount of $15,638.63. For the fiscal year ended August 31, 1923, the grand total of the sales account was $77,134.27.

The reason why the sales fund amounts to as much as it does at this time is attributed to the ruling by the Director, long enforced, to the effect that each substation or other branch of the Station System creating a sales fund is credited with that amount and has the opportunity of expending the money back in its work, by the use of the requisition and voucher system. In other words, no subdivision is robbed of that which it creates. The self-interest of the men, therefore, is thus indirectly satisfied by the money thus coming back, not to the men personally, but to the furtherance of their life work with which, obviously, they are concerned in an official way. If, therefore, the Station System were required to turn this sales fund in to the State Treasury, the amount annually available would be much less than that which is now received and used back in the work in lieu of that much appropriation which otherwise would have to be made by the State.

*The Matter of Securing Financial and Moral Support:*

The public gladly accepts any of the results of scientific study, yet is slow to invest in such work. It is more inclined to provide funds for work which promises immediate returns in terms of service. The man who can produce superior varieties of cotton, for example, can command by far better support than the man who determines the principles whereby such varieties may be more quickly produced. For this reason, the Agricultural Experiment Station System must be "sold" on the basis of service and the funds for the support of the necessary researches must come as an incident to the service aspect.

The Station System biennially faces an embarrassing situation, due to the "half-and-half" psychology of the State legislature. Because of the fact that many allotments from the Federal government must be duplicated by the State, the legislature is inclined to offer just half, for instance, of the salary requirements of the Station System, presuming that the Federal government will furnish the other half. Since we have but thirty thousand dollars per annum of Federal funds for Station work, the legislature is strongly inclined to force us to use all that money for salaries and merely to furnish an additional thirty thousand dollars of State money, thereby automatically fixing the salary total at sixty thousand dollars a year and no more, whereas our annual salary budget at the present time is $165,610.00. It would be a relief, therefore, if the Federal government should provide an additional eighty-five thousand dollars a year for Station work, so that, after providing half of the salaries from this source, there would still be something left from Federal funds for maintenance and support of the work itself.

There is a gradual increase in the amount of public support which the Station System receives as the results of previous researches become available and are found to be of great service to agricultural enterprise. The Agricultural Experiment Station System also grows in public favor with the gradual increase in the efficiency with which knowledge is disseminated throughout the population through the public school system and otherwise.

*Relation to State and Federal Departments:*

The relation of the research branch of the Agricultural and Mechanical College of Texas to the United States Department of Agriculture and the Texas State Department of Agriculture, as well as other agencies, is an important one. It serves all of them as being a source of reliable information pertaining to agriculture, and it serves directly the State Department of Agriculture and other agencies in so far as they are engaged in the dissemination of agricultural information, for only reliable information will stand the test with the people. In so far as the State Department of Agriculture does regulatory work, the Station System furnishes the basic information upon which just rules and regulations can be made.

The only question involved here is the recognition of this fact by the agency engaged in regulatory work. Certain regulatory measures are now being administered by the Station System, namely, the laws regulating the sale of feeding stuffs, and foul brood in honey bees, and have been administered by the Station since they were enacted into law. All rules and regulations put into effect in connection with these measures have been based upon research results made available by the Station System without fear or favor, and while some arguments have occurred, chiefly with the State Department of Agriculture to the effect that it could enforce these measures more economically than the Station, no one has been able successfully to contend that he could enforce them more efficiently and more in keeping with the spirit and purpose of the regulatory measures involved.

It should be emphasized that in connection with regulatory work administered by the Station System, unlike the State Department of Agriculture, we are not a "police" agency according to the intent and purpose of the regulatory laws now being administered. We are the fact-finding agency, investigating cases and their merits in the light of research, and all the facts therein developed are placed in the hands of the civil authorities. Ours is an educational administration of the laws, and the fact that several attempts have been made to remove the administration of these regulatory measures from the Station System through misconstruction of the kind and character of work involved have, without active opposition on our part, resulted each time in the active participation of the citizenship in retaining the work in its present location, is abundant evidence as to whether or not the work, as now being administered by this Station System, is meeting with the approval of the people.

The relation of the Station System to other research agencies maintained in the State of Texas by the United States Department of Agriculture has been, as a rule, a very cordial one. It is generally the policy of the United States Department of Agriculture, when working in the State, to devote its activities to problems of national scope rather than those of regional nature.

It should be mentioned here that the Station System renders service to any and all agricultural agencies in any way engaged in the advancement of agriculture directly or by the dissemination of information.

*The Nature of Agricultural Research:*

It is important that the nature of agricultural research should be understood by every one. In the first place, research should be established on a basis of permanency, inasmuch as civilization has advanced only through knowledge and so will agriculture advance through knowledge gained of agricultural problems and resources. Temporary research is an admission of only a partial solution of the problem, and it is well known that as economic and other conditions change, new and complex problems arise. It would seem, therefore, that our research should be established

on a basis of constant and continuous searching after facts, and that there should be a tendency on the part of the people to encourage research and to provide for its conduct in advance of the time when the information is actually needed. In this way, and in this way only, can research adequately fill its place and properly serve the people. Such a permanent research agency can be maintained only on lands permanently owned and permanently devoted to research purposes. Rented or leased lands, over which the research agency has only temporary control, contribute to temporary work—a type of research that is, as a rule, highly expensive and wasteful in that it is likely never brought to the most useful conclusions.

*Number and Nature of Projects:*

In the conduct of its research the Texas Station System employs a very definite system of projects. The value of this project system lies in its adaptation for directing research into the channels of greatest importance when the agricultural development of the State is considered. Moreover, the use of the project system tends to cause the research workers to adopt systematic methods of investigation. Mere investigation, without systematic effort in the collection and analysis of data, is likely to be inefficient and lacking in reliability. It should be emphasized that the very basis of research is accuracy and reliability of both data and conclusions, and to this end it is felt that the project system can be relied upon as insuring a safe preliminary basis for investigation. As a matter of fact, the project system is now generally used by all of the better research agencies.

At the present time, the Texas Station System has 71 active projects, each led by a worker who is a specialist in the particular field in which the study falls. Above all, the leader must familiarize himself with what has previously been done in the way of investigation relating to the project at hand, by investigators throughout the world, in order that he may not dissipate any of his time upon phases of the problem which have been solved by others. A necessary requirement of each and every project is that it refers to a specific line of investigation, so as to avoid too broad an assignment of effort to a given leader. This insures concentration of effort upon specific objectives and avoids "scatteration" and loss of the investigator's time. Realizing that each project has a special relation to agriculture in general, it is the policy of the Station System to coordinate the different investigations in such a manner that either one or several studies may be a contributing agency to one or more of our major problems in agriculture. For example, the study of Texas root rot involves not only the project of the plant pathologist and physiologist, but also some of the projects of the agronomist insofar as methods may be used in bringing about the curtailment of host plants other than cotton which harbor the disease. Likewise, it might involve physiological relations in the soil, and might also be affected, to some extent at least, by the chemical composition of the soil.

It will be seen, therefore, that limitation of the number of projects is a very important matter from the standpoint of keeping the investigations within the bounds of available facilities, and that coordination is important in assembling full and complete data relating to important control measures.

*Permanent Records:*

The system in use by the Station System involves the permanently recording of research. Each division and substation prepares and files, for a permanent record, a detailed report of its work each year. These reports, which are not for publication, are the storehouses of the information secured until a sufficient amount is accumulated on any phase of the work to justify a definite conclusion, at which time the information is taken from the storehouse and put into proper form for publication, setting forth not only the original data, but also the definite conclusions derived therefrom. It is obvious that there is much reserve information assembled in these unpublished annual reports, though it is not of value to the public until a sufficient amount is accumulated to enable accurate conclusions.

The annual reports submitted by the divisions and substations for file as permanent records usually contain from 200 to 300 pages each of typewritten material, much of which is tabular material, as compared with reports of not more than 50 to 60 pages in the case of the more comprehensive reports made in earlier days.

*Relation to the State Board of Control:*

The relation of the Station System to the State Board of Control may be set forth in a few words. It is considered that the research system involved in the solution of problems touching every official and private agency in the State should receive every consideration at the hands of the State Board of Control. It should also expect reductions where the Board may feel that reductions are wise in relation to good public policy. On the other hand, it should expect vigorous support of those items which are vital to the agricultural development of the commonwealth. Moreover, the Station System should have a certain amount of freedom from certain purchasing regulations and other restrictions which would tend to cause a loss of time and facilities for the prosecution of scientific research.

*Publications:*

The following is a comparative statement of publications issued by ten other states, and those issued by the Texas Station System, during the fiscal year 1920-21:

Publications Issued by Ten States and by Texas during the fiscal year 1920-21.

Agricultural Experiment Stations.

| State: | Number of Publications |
|---|---|
| Alabama | 4 |
| Arizona | 15 |
| California | 36 |
| Georgia | 4 |
| Indiana | 16 |
| Kansas | 12 |
| Mississippi | 19 |
| Ohio | 65* |
| South Carolina | 5 |
| Wisconsin | 23 |
| TEXAS | 26 |

*Includes press bulletins, monthly news bulletins, and other similar publications.

The foregoing tabulation shows that agricultural research in Texas is productive of immediate results in the form of publications issued by the Station System, which is the form in which the research worker makes available the findings and conclusions furnished by his conduct of scientific research. It will be noted that Texas ranks well up with such states as Wisconsin, Ohio, California, and Indiana, all of which are recognized as being of high rank in agricultural research. As previously stated, the rate of output and the quality of the publications of the Texas Station System are constantly increasing.

For some time the demand for our publications has been greater than the Station could supply. During the 19 months centering around the period covering by the foregoing tabluation, 83 per cent. of all publications printed were distributed, there being 43 publications during that period of time. Only a comparatively few of these went to general mailing lists, and only a small per cent. of these permanent scientific reports of investigations were retained for future years. Then, during the following twelve-months' period, 22 per cent. of the supply of old publications on hand was used, while during the past year 91 per cent. of the publications issued during that current year were distributed, along with 61,000 copies of older publications. The supply of recently issued bulletins and reports, in many instances, has been exhausted in less than one year from dating of issue. In many cases, publications are loaned, not only to research workers interested, but also to farmers and stockmen of the State, after the supply has gotten too low for distribution. It is evident, therefore, that while the rate of output of publications is high, there is a very heavy demand for the publications, and that since the principal

cost of a publication is the collection and interpretation of the information it contains, the Texas Station has not been adequately financed in respect to the publication of its results.

The following is a complete list, by number and title, of the bulletins issued from the organization of the Station on January 25, 1888, down to and including the fiscal year ended August 31, 1911:

Number Title:

1. Plan of Organization.
2. Experiments Started.
3. Grasses and Other Forage Plants.
4. Root Rot of Cotton or Cotton Blight.
5. Creameries in Texas.
6. Feeding Experiments.
7. Cotton Root Rot.
8. Work in Horticulture.
9. Pear Stocks.
10. Feeding Experiments No. 2.
11. Effects of Cotton Seed and Cotton Seed Meal on Butter Products.
12. The Screw-Worm.
13. Sorghum.
14. Effect of Cotton Seed and Cotton Seed Meal in the Dairy Ration.
15. Influence of Climate on Composition of Corn.
16. Work in Horticulture.
17. General Information.
18. Liver Flukes.
19. Corn Fodder.
20. Grasses and Forage Plants.
21. Effect of Cotton Seed and Cotton Seed Meal in Feeding Hogs.
22. Alfalfa Root Rot.
23. Black Rot of the Grape.
24. The Cattle Tick.
25. Texas Soils.
26. Cost of Cotton Production and Profit Per Acre.
27. Steer Feeding.
28. Sweet Potatoes.
29. Effects of Cotton Seed and Cotton Seed Meal on Butter, Beef Tallow, Lard, and Sheep Suet.
30. Veterinary Science.
31. Insects Injurious to Stored Grain.
32. Test of Plums, Apricots, and Japan Persimmons.
33. Feeding Milk Cows.
34. Field Experiments with Corn, Cotton, Grasses, Peas, and Manures.

35. Miscellaneous Chemical Analysis.
36. Vegetables.
37. Sundry Brief Articles Compiled from Press Notes Published During the Years 1894 and 1895.
38. Canaigre, the New Tanning Plant.
39. The Peach.
40. Field Experiments at College Station, With Corn, Cotton, and Forage Plants.
41. Steer Feeding.
42. The Irish Potato.
43. Report from Beeville Station.
44. Paints and Painting Materials.
45. Cotton Experiments.
46. Grasses and Forage Plants.
47. The Effect of Food on Economic Dairy Production.
48. The Grape.
49. Corn Experiments.
50. Cotton Experiments.
51. Fertilizers and Fertilizer Analysis.
52. Report of Beeville Station on Cabbage and Cauliflower.
53. The Texas Fever.
54. The Irish Potato.
55. I. Feeding Steers.
    II. Feed Value of Cotton Seed and Its Products.
56. Investigation and Improvement of American Grapes.
57. Cabbage and Cauliflower.
58. Pruning and Training Peach Orchards.
59. Forage Crops.
60. Cultivation of Onions.
61. Willis and Huntsville Tobacco Soils.
62. The Fig.
63. Texas Fever.
64. Insect Pests Attacking Truck Crops.
65. The Tomato.
66. Forage Crops.
67. Commercial Fertilizers and Commercial Poisonous Insecticides.
68. The Manufacture of Cane Syrup.
69. Cabbage.
70. The Composition of Texas Cottonseed Meal.
71. Irish Potatoes.
72. Strawberries at Troupe Station .
73. The Composition of Rice.
74. Insects Mistaken for the Mexican Cotton Boll Weevil.
75. Cotton Investigations.
76. Experiments in Steer Feeding.
77. Onions and Bunch Crops.
78. Feeding Fermented Cottonseed Meal to Hogs.

79. Cotton Breeding.
80. Peach Growing in Texas.
81. Alfalfa Seed Testing.
82. Maintaining the Fertility of Rice Soils; a Chemical Study.
83. Nitro--Culture.
84. Tomato Fertilizers at Troupe.
85. Commercial Fertilizers in 1905-6.
86. Cattle Feeding Experiments.
87. The San Jose Scale.
88. Horticulture Section.
89. Insects of the Garden.
90. The Feed Control in 1905-6.
91. Food Adulteration in Texas.
92. A Test of the Producing Power of Some Texas Seed Corn.
93. The Sweet Potato Borer.
94. Horticultural Survey of the Gulf Coast.
95. Information Regarding the New Feed Law.
96. Commercial Fertilizers and Poisonous Insecticides in 1906-7.
97. Kafir Corn and Milo Maize for Fattening Cattle.
98. Summary: Texas Bulletins Nos. 1 to 94.
99. The Composition and Properties of Some Texas Soils.
100. The Chemical Composition of Some Texas Soils.
101. Irish Potato Fertilizer Experiments.
102. Department of Entomology; Texas Honey Plants.
103. Cooperative Forage Crop Investigations.
104. Digestion Experiments.
105. Forest and Ornamental Trees.
106. The Production of Active Nitrogen in the Soil.
107. Commercial Fertilizers and Poisonous Insecticides in 1907-8.
108. Winter Burr Clover.
109. Alfalfa.
110. Steer Feeding Experiments.
111. Texas Fever.
112. Nature and Use of Commercial Fertilizers.
113. Spray Calendar.
114. Composition of White Lead and Paints.
115. Fertilizer Test with Onions.
116. The Foul Brood of Bees and the Foul Brood Law.
117. Commercial Feeding Stuffs in 1907-8.
118. Report of Progress with Citrus Fruits.
119. *Infectious Anaemia* of the Horse.
120. Corn and Cotton Experiments for 1908.
121. Report of Progress at the Troupe Substation.
122. Effect of Salt Water on Rice.
123. Commercial Fertilizers and Poisonous Insecticides in 1908-9.
124. The Pecan Case-Bearer.
125. The Chemical Composition of Some Soils of Angelina, Brazoria,

Cameron, Cherokee, Delta, Lamar, Hidalgo, Lavaca, Montgomery, Nacogdoches, etc., Counties.

126. Active Phosphoric Acid and Its Relation to the Needs of the Soil For Phosphoric Acid in Pot Experiments.
127. Commercial Feeding Stuffs.
128. Cottonseed Meal as Human Food.
129. Studies of the Ammonia-Soluble Organic Matter of the Soil.
130. Alkali Soils; Irrigation Waters.
131. Hog Feeding Experiments.
132. Report of the Cooperative Forage Crop Work by the U. S. Department of Agriculture and Texas State Experiment Station at Chillicothe, 1909.
133. Commercial Fertilizers.
134. Report of the Director on the Establishment of the New State Stations.
135. Feeding Experiments with Steers and Hogs.
136. Organic Phosphoric Acid.
137. Alfalfa in Northwest Texas.
138. Cooperative Fertilizer Experiments, 1908, 1909, 1910.
139. Electrolysis of Humus Solutions.
140. Commercial Fertilizers.
141. Commercial Feeding Stuffs.

The foregoing bulletins, 141 in number, were issued by the Station from its organization until the close of the fiscal year on August 31, 1911.

The following list of bulletins, 178 in number, have been issued since the beginning of the fiscal year on September 1, 1911, down to the present date, or since the administration of the present Director of the Station System:

Number: Title:

142. Practical Information for Beginners in Beekeeping.
143. Observations on European Agriculture.
144. Culture of Cigar Leaf Tobacco in Texas.
145. Active Potash of the Soil and Its Relations to Pot Experiments.
146. Forms of Phosphorus in Cottonseed Meal.
147. Digestion Experiments with Texas Hays and Fodders.
148. Report on Experiments with Citrus Fruits at the Beeville Substation.
149. Commercial Fertilizers in 1911-1912.
150. Composition and Digestibility of the Ether-Extract of Hays and Fodders.
151. Relation of the Total Nitrogen of the Soil to its Needs as Shown in Pot Experiments.
152. The Heating of Corn Chops.
153. A Test of the Relative Values of Cottonseed Meal and Cottonseed Hulls for Fattening Cattle.
154. Commercial Feeding Stuffs.

155. The Ether-Extract and the Chloroform-Extract of Soils.
156. The Phosphorus Compounds of Cottonseed Meal and Wheat Bran.
157. Hog Cholera and Its Prevention.
158. Investigations Pertaining to Texas Beekeeping.
159. Steer Feeding.
160. Commercial Fertilizers in 1912-13.
161. The Composition of the Soils of South Texas.
162. Composition and Digestibility of the Chloroform-Extract of Hays and Fodders.
163. Digestion Experiments on Men with Cottonseed Meal.
164. Commercial Feeding Stuffs.
165. Ammonia-Soluble Inorganic Soil Colloids.
166. Digestion Experiments with Texas Feeding Stuffs.
167. Commercial Fertilizers and Their Use.
168. Commercial Fertilizers in 1913-14.
169. The Total Fatty Acids and Other Ether-Soluble Constituents of Feedstuffs.
170. Texas Feeding Stuffs: Their Composition and Utilization.
171. Losses of Moisture and Plant Food by Percolation.
172. Sudan Grass.
173. The Composition of the Soils of the Texas Panhandle.
174. The Effect of Organic Compounds in Pot Experiments.
175. Distribution and Digestibility of the Pentosans of Feeds.
176. Commercial Fertilizers in 1914-15.
177. Commercial Feeding Stuffs 1914-15.
178. Effect of the Additions on Availability of Soil Phosphates.
179. The Harlequin Cabbage-Bug.
180. The Turnip Louse.
181. Oxidation of Organic Compounds in the Soil.
182. Steer Feeding.
183. Moisture Relations of Some Texas Soils.
184. Cooperative Fertilizer Experiments with Corn 1908-1914.
185. The Production Coefficient of Feeds.
186. Fattening Lambs.
187. Sprays and Spraying.
188. Tile Drainage.
189. The Composition of Cottonseed Meal and Cottonseed.
190. The Effect of Additions on the Availability of Soil Potash, and the Preparation of Sugar Humus.
191. The Composition of Rice and Its By-Products.
192. Soils of Grayson, Lee, McLennan, Titus, and Tyler Counties.
193. Commercial Fertilizers in 1915-16.
194. Commercial Feeding Stuffs 1915-16.
195. Japanese Sugar Cane as a Forage Crop.
196. Digestibility of Sugars, Starches, and Pentosans of Roughages.

197. Progress Report of Substation No. 3, Angleton, Texas, 1909-1914.
198. Feeding Baby Beeves.
199. Progress Report, Texas Substation No. 6, Denton, Texas, 1909-1914.
200. Progress Report, Substation No. 4, Beaumont, Texas, 1909-1914.
201. Peanut Meal and Ground Whole Pressed Peanuts for Hogs.
202. Progress Report of Substation No. 12, Chillicothe, Texas, 1905-1914.
203. The productive Values of Some Texas Feeding Stuffs.
204. The Recurving of Milo and Some Factors Influencing It.
205. Sheep Breeding and Feeding.
206. Poultry Feeds and Feeding Results.
207. Poultry Houses and Poultry Equipment for Texas.
208. The Fig in Texas.
209. Progress Report, Substation No. 2, Troup, Texas, 1901-1914.
210. Barns for Work Animals.
211. Field Experiments with Crown Gall, 1913-17.
212. The Availability of Phosphoric Acid in Rock Phosphate.
213. The Composition of the Soils of South Central Texas.
214. Progress Report, Substation No. 1, Beeville, Texas, 1910-14.
215. Progress Report, Substation No. 5, Temple, Texas, 1910-14.
216. Commercial Feeding Stuffs 1916-17.
217. Commercial Fertilizers in 1916-17.
218. Progress Report, Substation No. 7, Spur, Texas, 1909-14.
219. Progress Report, Substation No. 8, Lubbock, Texas, 1909-1914.
220. Egg Producing Values of Some Texas Feeding Stuffs.
221. Progress Report, Substation No. 9, Pecos, Texas, 1910-1914.
222. The Composition of Peanuts and Peanut By-Products.
223. Effects of Lime and Carbonate of Lime on Acid Phosphate.
224. The Influence of Peanuts and Rice Bran on the Quality of Pork.
225. Cocoanut Meal versus Cottonseed Meal for Dairy Cows.
226. Cooperative Soft Pork Investigations.
227. Studies on the Harlequin Bug.
228. Influence of Peanut Meal on the Quality of Pork.
229. Experiments at Substation No. 3, Angleton, Texas, 1909-1916.
230. Spacing of Rows of Corn and Its Effect on Grain Yield.
231. The Beemoth or Waxworm.
232. Mineral Requirements of Sheep.
233. Commercial Fertilizers in 1917-1918.
234. Commercial Feeding Stuffs in 1917-1918.
235. Cooperative Fertilizer Experiments with Cotton, Corn, Sweet Potatoes, and Irish Potatoes, 1908-1917.
236. Grain Sorghum Improvement.

237. Progress Report, Substation No. 11, Nacogdoches, Texas, 1909-1914.
238. Dairy Cattle Feeding Experiments.
239. Control of Weeds in Rice Fields.
240. The Utilization of *Yucca* for the Maintenance of Cattle.
241. Cotton Seed Meal.
242. Hardening Peanut-Fed Hogs.
243. The Needs of Texas Soils for Lime.
244. Composition of the Soils of Archer, Franklin, and Harrison Counties.
245. Feeding Values of Certain Texas Feeding Stuffs.
246. Report of the First Texas National Egg-Laying Contest.
247. The Chemical Composition of the Cotton Plant.
248. Commercial Fertilizers in 1918-19.
249. Field Diseases of the Sweet Potato in Texas.
250. Storage and Storage Diseases of Sweet Potatoes in Texas.
251. Commercial Feeding Stuffs September 1, 1918, to August 31, 1919.
252. Commercial Feeding Stuffs Registered for Sale in Texas, October 1, 1919.
253. Report of Experiments at Substation No. 12, Chillicothe, Texas, 1915-1917.
254. Report of Experiments at Substation No. 11, Nacogdoches, Texas, 1916-1918.
255. Beekeeping for Beginners.
256. The Cowpea Weevil.
257. The Cotton or Melon Louse: Life-History Studies.
258. Report of Experiments, Substation No. 4, Beaumont, Texas, 1915-1918.
259. Nitrification in Texas Soils.
260. Wilts of the Watermelon and Related Crops.
261. Diseases of Grains, Sorghums, and Millet, and Their Control in Texas.
262. The Searing Iron versus the Knife for Docking or De-Tailing Lambs.
263. Rations for Fattening Steers.
264. Farm Records and Accounts.
265. Commercial Fertilizers in 1919-1920.
266. The Staple of Texas Cotton.
267. The Relation of the Phosphoric Acid of the Soil to Pot Experiments.
268. Commercial Feeding Stuffs: September 1, 1919, to August 31, 1920.
269. Grain Sorghums versus Corn for Fattening Lambs.
270. A Study of the Black and the Yellow Molds of Ear Corn.
271. The Salt or Sodium Chloride Content of Feeds.

272. The Chemical Composition of Texas Honey and Pecans.
273. Pink Root Disease of Onions and Its Control in Texas.
274. Cotton Variety Experiments, Substation No. 3, Angleton, Texas.
275. Spur Feterita.
276. Corn Variety Experiments, Substation No. 3, Angleton, Texas. Troup.
277. Sweet Potato Fertilizer Experiments at Substation No. 2,
278. Farm Tenantry in the United States.
279. Type and Variability in Kafir.
280. Commercial Fertilizers in 1920-1921.
281. Commercial Feeding Stuffs: September 1, 1920, to August 31, 1921.
282. The Composition and Feeding Values of Wheat By-Products.
283. The Relation of Soil Nitrogen, Nitrification, and Ammonification to Pot Experiments.
284. Availability of Potash in Some Soil-Forming Minerals.
285. Grain Sorghums Versus Corn for Fattening Lambs.
286. Rice Bran for Fattening Hogs.
287. Availability of Some Nitrogenous and Phosphatic Materials.
288. Cotton Variety Experiments, 1912-1920, Substation No. 7, Spur, Texas.
289. The Effect of Rock Phosphate Upon the Corn Possibility of the Phosphoric Acid of the Soil.
290. Digestibility of the Sugars, Starches, Pentosans and Proteids of Some Feeding Stuffs.
291. Digestion Experiments.
292. The Blueweed and Its Eradication.
293. Cultivation and Care of Trees on Texas Farms.
294. Shelling Percentages in Grain Sorghum.
295. Correlation Between External Body Characters and Annual Egg Production in White Leghorn Fowls.
296. Grain Sorghums versus Corn for Fattening Baby Beeves.
297. An Economic Study of a Typical Ranching Area on the Edwards Plateau of Texas.
298. Commercial Fertilizers in 1921-22.
299. Varieties of Cotton in Northwest Texas.
300. Organic Constituents of the Soil.
301. Soils of Bell, Jefferson, Smith, Taylor, and Webb Counties.
302. The Needs of the Soils of Brazos and Jefferson Counties for Sulphur.
303. Commercial Feeding Stuffs: September 1, 1921, to August 31, 1922.
304. The Fixation of Phosphoric Acid by the Soil.
305. Swine Feeding Experiments.
306. Grain Sorghums versus Corn for Fattening Lambs (Third Experiment).

307. Texas Root Rot of Cotton and Methods of Its Control.
308. The Sweet Potato Weevil.
309. I. Fattening Steers on Cottonseed Meal and Hulls with and Without Corn.
II. The Influence of Age in Fattening Steers.
310. The Interpretation of Correlation Data.
311. The Influence of Individuality, Age, and Season Upon the Weights of Fleeces Produced by Range Sheep.
312. Commercial Fertilizers in 1922-23.
313. Rice Bran and Rice Polish for Growing and Fattening Pigs.
314. Commercial Feeding Stuffs: September 1, 1922, to August 31, 1923.
315. Digestion Experiments with Oat By-Products and other Feeds, Report No. 7.
316. The Soils of Brazos, Camp, Ellis, and Washington Counties.
317. Comparative Influences of Various Protein Feeds on Laying Hens.
318. The Relation Between Rents and Agricultural Land Values in Theory and in Practice.
319. Field and Laboratory Notes on a Fatal Disease of Cattle Occurring on the Costal Plains of Texas (Loin Disease).

It should be borne in mind that the editions of many of the earlier issues have been exhausted for a good many years.

## LANDS

The following table shows the lands owned and operated by the Station System for agricultural research purposes:

| Designation | Acres of land devoted to various uses | | | |
|---|---|---|---|---|
| | Area | Cultivation | Pasture | Farmstead, roadways, and miscellaneous |
| TOTAL | 6535.07 | 1293.60 | 5082.27 | 159.2 |
| Main Station Farm | *127 | 98 | 11 | 18 |
| Division of Veterinary Science | *141 | 5 | 130 | 6 |
| Substation No. 1, Beeville | 151.5 | 63.2 | 84.3 | 4 |
| 2, Troup | 150 | 50 | 90 | 10 |
| 3, Angleton | 157 | 51 | 100 | 6 |
| 4, Beaumont | 100 | 60 | 30 | 10 |
| 5, Temple | 96 | 37 | 55 | 4 |
| 6, Denton | 209.92 | 163 | 34.92 | 12 |
| 7, Spur | 406.35 | 104 | 292.35 | 10 |
| 8, Lubbock | 160 | 109 | 41 | 10 |
| 9, Balmorhea | 200 | 68 | 120 | 12 |
| 10, College Station | **901.8 | 212 | 674.8 | 15 |
| 11, Nacogdoches | 82.5 | 33.4 | 38.9 | 10.2 |
| 12, Chillicothe | 100 | 80 | 10 | 10 |
| 14, Sonora | 3452 | 65 | 3367 | 20 |
| 15, Llano Grande | 100 | 95 | 3 | 2 |

*Included in the main tract of College land.
**Includes 636 acres of the College's main tract and 265.8 acres purchased later for research purposes.

*Financial Support:*

The following is a chronological statement of the financial support received by the Texas Agricultural Experiment Station System, through Federal allotment and State appropriation, from its organization on January 25, 1888, down to and including the State's fiscal year ending August 31, 1925:

| Year | Total | Federal funds | | State appropriations | |
|---|---|---|---|---|---|
| | | Hatch | Adams | Substations | Main Station |
| 1888 | $15,000 | $15,000 | $ none | $ none | $ none |
| 1889 | 15,000 | 15,000 | none | none | none |
| 1890 | 15,000 | 15,000 | none | none | none |
| 1891 | 15,000 | 15,000 | none | none | none |
| 1892 | 15,000 | 15,000 | none | none | none |
| 1893 | 15,000 | 15,000 | none | none | none |
| 1894 | 20,000 | 15,000 | none | 5,000 | none |
| 1895 | 17,500 | 15,000 | none | 2,500 | none |
| 1896 | 17,500 | 15,000 | none | 2,500 | none |
| 1897 | 17,500 | 15,000 | none | 2,500 | none |
| 1898 | 17,500 | 15,000 | none | 2,500 | none |
| 1899 | 17,500 | 15,000 | none | 2,500 | none |
| 1900 | 17,500 | 15,000 | none | 2,500 | none |
| 1901 | 17,500 | 15,000 | none | 2,500 | none |
| 1902 | 17,500 | 15,000 | none | 2,500 | none |
| 1903 | 21,000 | 15,000 | none | 6,000 | none |
| 1904 | 22,000 | 15,000 | none | 7,000 | none |
| 1905 | 22,000 | 15,000 | none | 7,000 | none |
| 1906 | 22,000 | 15,000 | none | 7,000 | none |
| 1907 | 27,000 | 15,000 | 5,000 | 7,000 | none |
| 1908 | 29,000 | 15,000 | 7,000 | 7,000 | none |
| 1909 | 31,000 | 15,000 | 9,000 | 7,000 | none |
| 1910 | 58,000 | 15,000 | 11,000 | 32,000 | none |
| 1911 | 60,000 | 15,000 | 13,000 | 32,000 | none |
| 1912 | 85,000 | 15,000 | 15,000 | 53,000 | 2,000 |
| 1913 | 85,000 | 15,000 | 15,000 | 53,000 | 2,000 |
| 1914 | 117,500 | 15,000 | 15,000 | 72,500 | 15,000 |
| 1915 | 117,500 | 15,000 | 15,000 | 72,500 | 15,000 |
| 1916 | 170,582 | 15,000 | 15,000 | 115,582 | 25,000 |
| 1917 | 165,000 | 15,000 | 15,000 | 110,000 | 25,000 |
| 1918 | 260,856 | 15,000 | 15,000 | 120,128 | 110,728 |
| 1919 | 224,970 | 15,000 | 15,000 | 97,032 | 97,938 |
| 1920 | 222,540 | 15,000 | 15,000 | 90,020 | 102,520 |
| 1921 | 222,540 | 15,000 | 15,000 | 91,030 | 101,510 |
| 1922 | 231,535 | 15,000 | 15,000 | 88,585 | 112,950 |
| 1923 | 227,985 | 15,000 | 15,000 | 82,485 | 115,500 |
| 1924 | 324,000 | 15,000 | 15,000 | 155,000 | 139,000 |
| 1925 | 247,000 | 15,000 | 15,000 | 84,000 | 133,000 |

The following tabulation gives a comparison of the funds available for research purposes in Texas and those provided for similar purposes in ten other states representative of both very similar and widely different agricultural conditions:

SHOWING INCOMES PER FARM, PER INHABITANT, AND SO FORTH, AND TOTAL INCOMES OF THE EXPERIMENT STATION SYSTEMS OF CERTAIN STATES. FIGURES BASED ON THE 1920 CENSUS AND REPORT ON WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS FOR THE FISCAL YEAR ENDING JUNE 30, 1921.

| State | No. Exp. Fields, Substations & Outlying Labs. | Appropriations | | Other Revenue | Total Revenue | Population 1920 Census | Funds Per Inhabitant | Area in Acres | No. Farms 1920 Census | Funds per Farm | Value of Agricultural Crops. | Available Research Funds per Dollar of Total Crop Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Federal | State | | | | | | | | | |
| Ohio | 16 | 30,000.00 | 265,365.00 | 102,002.27 | 397,367.27 | 5,759,394 | .068 | 26,078,600 | 256,695 | 1.55 | 607,037,562 | .65 Mills |
| California | 11 | 30,000.00 | 147,378.71 | 106,948.40 | 284,327.11 | 3,426,861 | .082 | 99,617,280 | 117,670 | 2.42 | 589,757,377 | .48 Mills |
| Kansas | 5 | 30,000.00 | 82,000.00 | 82,932.90 | 194,932.90 | 1,769,257 | .110 | 52,335,360 | 165,286 | 1.18 | 588,923,248 | .33 Mills |
| Arizona | 6 | 30,000.00 | 49,281.97 | 25,228.18 | 104,510.15 | 334,162 | .312 | 72,838,400 | 9,975 | 10.48 | 42,481,230 | 2.46 Mills |
| Wisconsin | 8 | 30,000.00 | 210,000.00 | | 210,000.00 | 2,632,067 | .091 | 35,363,840 | 189,295 | 1.27 | 445,347,868 | .54 Mills |
| Alabama | 2 | 30,000.00 | 31,500.00 | 9,837.41 | 71,337.41 | 2,348,174 | .031 | 32,818,560 | 256,099 | .29 | 304,348,638 | .24 Mills |
| Mississippi | 5 | 30,000.00 | 94,829.53 | 24,357.97 | 149,187.50 | 1,790,618 | .083 | 29,671,680 | 272,101 | .55 | 336,207,156 | .44 Mills |
| Georgia | 1 | 30,000.00 | 51.08 | 11,369.29 | 41,420.37 | 2,895,832 | .014 | 37,584,000 | 310,732 | .13 | 540,613,626 | .08 Mills |
| Indiana | 19 | 30,000.00 | 150,232.87 | 279,367.25 | 459,600.12 | 2,930,390 | .156 | 23,068,800 | 205,126 | 2.24 | 497,229,719 | .92 Mills |
| South Carolina | 3 | 30,000.00 | 50,000.00 | 21,527.61 | 101,527.61 | 1,683,724 | .060 | 19,516,800 | 192,693 | .53 | 437,121,837 | .23 Mills |
| Texas | 18 | 30,000.00 | 220,519.17 | 61,289.38 | 311,808.55 | 4,663,228 | .066 | 167,934,720 | 436,033 | .71 | 1,071,542,103 | .29 Mills |

The foregoing table brings out, among other things, the following facts:

1. The Texas Station, in large measure, is dependent upon direct State appropriations for its support.

2. In comparison with the number of inhabitants in Texas, the funds per inhabitant for research work are very small. This is particularly pertinent because of the large proportion of the population of Texas which is strictly agriculture. It may be fairly said, therefore, that Texas in view of her southwestern and somewhat isolated condition and new problems, is appropriating a very small amount of money per inhabitant for research in agriculture; the amount being approximately equivalent to those amounts available in South Carolina and Ohio; less than in Mississippi, Wisconsin, and California, and about half as much as in Indiana and Kansas, and about one-fifth as much as in Arizona.

3. In landed area, Texas is approximately 170 per cent, as large as California, and Texas is very much larger than any other state included in the table. Ohio, for instance, is spending one dollar in agricultural research for every sixty-five acres of land, and Indiana one dollar on every fifty acres, whereas in Texas only one dollar is spent on 558 acres.

4. Farms and ranches in Texas are large. There is much "pioneer agriculture" in Texas. The Texas Station System alone is practically the leader in paying attention to ranch agriculture and ranch economics. There are many more farms in Texas than in any other state given in the table, yet on the average the expenditure per farm for research is very small, 71 cents for the average farm, whereas the State of California spends about three-and-one-half times as much, and Arizona nearly fifteen times as much.

5. Texas ranks first among the states mentioned in the value of agricultural crops, not including livestock and livestock products in which she is likewise noted. Nevertheless, the other states spend a great deal more money for research, in comparison with the value of their agricultural crops, than Texas. As the contribution of research to crop values is well known, it might be stated that this situation is due to the efficient service rendered per dollar invested. The pressing need of the solution of the problems now under investigation and those not as yet studied is all the more reason for the conclusion that further expenditure for research in Texas would be abundantly justified.

6. The usefulness of the substation method of conducting investigations dealing with subjects having regional applications is not a question in Texas, which, large as it is, would have many more of these outlying laboratories, or substations, if the State were to devote proportionately the same amount of money or the same attention to them as is done in some of the smaller states, notably Ohio, California, Wisconsin, Mississippi, and South Carolina.

Viewed in the light of an investment, it is apparent that agricultural research in Texas is lacking in financial support in proportion to

the efficiency with which it is conducted, the results secured, the area and the size of the State, and the importance placed upon this kind of work in other states.

*Personnel:*

The personnel of the staff of the Texas Agricultural Experiment Station System, including the duties, the educational training and the experience of each worker, will be found in the following table:

# PERSONNEL OF TEXAS AGRICULTURAL EXPERIMENT STATION STAFF.

## Technical Research Workers on Full Time.

| Name | Title | Location | Present Duties | | | | | Educational Training | | | | | | Experience | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Research | Adm. Research | Control | Adm. Control | Teaching | Degrees B.- | Degrees M.- | Degrees Doctor's | Inst. Conf. Highest Deg. | Major for Advanced Deg. | No. of Years in This Station | No. Years in Research Work | No. Years in U. or College Wk. Other Than Res'h. | No. Years in Educational Work Below U. or College Grade |
| E. Youngblood | Director | Main Station | x | x | x | x | x | s | s | Ph.D. | Wisconsin | Agr. Ec. | 12 1-2 | 16 1-2 | | 4 |
| A. B. Conner | Vice-Director | Main Station | x | x | | | | s | s | | Tex. A.& M.C. | Genetics | 13 1-2 | 19 1-2 | | |
| A. H. Leidigh | Ass't Director | Main Station | x | x | | | | s | s | | Tex. A.& M.C. | Genetics | 10 1-2 | 17 | 1 1-2 | |
| M. Francis | Chief, Vet. Sc. | Main Station | | | | | x | | | DVM. | Ohio State U. | Vet. | 36 | Combined Teaching & Research | | |
| H. Schmidt | Veterinarian | Main Station | x | x | | | | s | | DVM. | Royal Vet. Col. | Berlin | 11 | 11 | | |
| V. J. Brauner | Veterinarian | Main Station | x | | | | | | | DVM. | Tex. A.& M.C. | | 1 1-2 | 2 1-2 | | |
| G. S. Fraps | State Chem., Chief | Main Station | x | x | x | x | | s | | Ph.D. | Johns Hopkins U. | Chem. | 21 | 21 | 5 | |
| S. E. Asbury | Ass't Chemist | Main Station | x | | | | | s | s | | N.C.St.Agr.Col. | Chem. | 20 | 20 | 1 | |
| W. H. Walker | Ass't Chemist | Main Station | x | | | | | (High School) | | | | | 5 1-2 | 5 1-2 | | |
| J. E. Teague | Ass't Chemist | Main Station | x | | | | | s | | | N.C.St. Col. | | 9-mo. | | | |
| J. K. Blum | Ass't Chemist | Main Station | x | | | | | s | | | N.C.St. Col. | | 8 1-2m. | | | |
| A. T. Potts | Chief, Horticulture | Main Station | x | x | | | | s | s.c. | | Univ. Calif. | | | | | |
| | | | | | | | | s | s.a. | | Tex. A.& M.C. | Hort. Cit | 5 | 5 | 9 | |
| J. M. Jones | Chief, Animal Ind. | Main Station | x | x | | | | s | a | | Univ. Mo. | A. Husb. | 9 1-2 | 11 1-2 | 2 | |
| J. L. Lush | Animal Husbandman | Main Station | x | | | | | s | s | Ph.D. | Univ. Wis. | Genetics | 2 1-2 | 2 1-2 | 2-Tech. Ass't. | 1 1-2 |
| G. R. Warren | Swine Husbandman | Main, in charge F.&B. | x | | | | | s | | | Tex. A.& M.C. | | 5 1-2 | 5 1-2 | | 2 |
| R. M. Sherwood | Poul. Husbandman | Main Station | x | | | | | s | | | Ames | | 4 1-2 | 4 1-2 | 7 | |
| J. J. Hunt | Wool Grader | Main Station | x | | | | | (Col. Agri., Wyo. & Tex. A.& M.C. Wool Work) | | | | | | | | |
| M. C. Tanquary | Chief, State Entom. | Main Station | x | x | x | | | s | a | Ph.D. | Univ. Ill. | Entom. | 4 1-2 | 13 1-2 | 5 | |
| H. J. Reinhard | Entomologist | Main Station | x | | | | | s | | | Ohio State | | 7 1-2 | 7 1-2 | | 1 |
| C. S. Rude | Entomologist | Field | | | x | | | s | | | Kans. St. A.C. | | 4 | 4 | | |
| H. S. Cavitt | Apiary Inspector | Field | | | x | | | s | | | Conn. A.C. | | ? | | | |
| W. R. Jordan | Apiary Inspector | Field | | | x | | | s | | | Tex. A.& M.C. | | 11-mo. | | | |
| E. B. Reynolds | Chief, Agronomy | Main Station | x | x | | | | s | s | | Ames | Soils | 5 1-2 | 5 1-2 | 5 | |
| G. N. Stroman | Cottor Breeder | Main Station | x | | | | | s | s | Ph.D. | Univ. Wis. | Genetics | 1 1-2 | 1 1-2 | | |
| C. H. Mahoney | Ass't Cot. Breeder | Main Station | x | | | | | s | | | Univ. Ariz. | | 4 1-2-mo. | | | |
| J. J. Taubenhaus | Chief, Plant Path. & Phys. | Main Station | x | x | | | | s | s | Ph.D. | Pa. Univ. | Plant P. | 8 | 8 | 7 | |

Continuation of Personnel of Texas Agricultural Experiment Station Staff—Technical Research Workers on Full Time.

| Name | Title | Location | Present Duties | | | | | Educational Training | | | | | Experience | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Research | Adm. Research | Control | Adm. Control | Teaching | Degrees B.— | Degrees M.— | Degrees Doctor's | Inst. Conf. Highest Deg. | Major for Advanced Deg. | No. of Years in This Station | No. Years in Research Work | No. Years in U. or College Wk. Other Than Res'h. | No. Years in Educational Work Below U. or College Grade |
| L. P. Gabbard | Chief, Div. Farm and Ranch Economics | Main Station | x | x | | | | s | s | | Univ. Wis. | Agri.Ec. | 1 3-4 | 2 1-4 | 2 | 5 |
| V. L. Cory | Grazing Res'h Botanist | Sub.No.14 (Temp.) | x | | | | | s | s | | Univ. Minn. | | 8 | 8 | 16 | 1 |
| H. E. Rea | Assistant | Main Station | x | | | | | s | | | Tex. A.& M.C. | | 1 | 1 | | |
| W. T. Carter | Chief, Soil Survey | Field | x | x | | | | s | | | Tex. A.& M.C. | | 6 | 23 | | |
| H. W. Hawker | Soil Surveyor | Field | x | | | | | | | | | | 4 | 4 | | |
| Edward Templin | Soil Surveyor | Field | x | | | | | s | | | Univ. Wis. | | 5 1-2-mo. | 1 | | |
| H. Ness | Chief, Botany | Main Station | x | x | | | | s | s | | Cornell | Bot. | 16 | 16 | 16 | |
| H. B. Parks | Apiculturist | San Antonio Apicul. Laby. | x | | | | | s | | | Blackburn U. | | 3 3-4 | 3 3-4 | 8 | |
| A. H. Alex | Queen Breeder | Apicul. Laby. | x | | | | | s | | | Tex. A.& M.C. | | 3 3-4 | 3 3-4 | | 7 |
| D. T. Killough | Superintendent | Main Station | x | | | | | s | | | Tex. A.& M.C. | | 9 3-4 | 9 3-4 | | |
| P. D. Fuller | Chief, Feed Control Ser. | Main Station | | | x | | | s | s | | Purdue Univ. | | 6 1-2 | 28 3-4 | 1-2 | |
| J. H. Rogers | Inspector | Field | | | x | | | | | | | | 17 | 17 | | |
| W. H. Wood | Inspector | Field | | | x | | | | | | | | 14 | 14 | | |
| J. D. Prewit | Inspector | Field | | | x | | | s | | | Tex. A.& M.C. | | 7-mo. | 7 mo. | | |
| T. C. Davis | Inspector | Field | | | x | | | s | | | Tex. A.& M.C. | | 1-mo. | 1 mo. | | |
| J. F. Schultz | Inspector | Field | | | x | | | s | | | Tex. A.& M.C. | | 1-mo. | 1 mo. | | |
| R. A. Hall | Superintendent | Substation No.1 | x | | | | | s | | | Tex. A.& M.C. | | 1 1-2-mo | | | |
| W. S. Hotchkiss | Superintendent | Substation No.2 | x | | | | | | | | Mich.A.C.3-yr | | 20 1-2 | 26 1-2 | | 4-Extension |
| V. E. Hafner | Superintendent | Substation No.3 | x | | | | | s | | | Tex. A.& M.C. | | | 3 1-2 | | |
| R. H. Wyche | Superintendent | Substation No.4 | x | | | | | s | | | Tex. A.& M.C. | | | 2 1-2 mo | | |
| A. B. Cron | Superintendent | Substation No.5 | x | | | | | s | | | Kans. St.A.C. | | | 16 | | |
| P. B. Dunkle | Superintendent | Substation No.6 | x | | | | | s | | | Tex. A.& M.C. | | 1 1-2 | 1 1-2 | | |
| R. E. Dickson | Superintendent | Substation No.7 | x | | | | | s | | | Tex. A.& M.C. | | 9-yr.10-mo. | 9 10-mo. | | 3-Extension |
| R. E. Karper | Superintendent | Substation No.8 | x | | | | | s | | | Kans. St.A.C. | | 8 5-mo. | 10 | | |
| J. J. Bayless | Superintendent | Substation No.9 | x | | | | | s | | | Kans. St.A.C. | | 1 1-2 | 3 1-2 | | |
| L. J. McCall | Superintendent | F.& B. (Farm) | x | | | | | | | | | | 4 1-2 | 4 1-2 | | 1-Extension |
| G. T. McNess | Superintendent | Substation No.11 | x | | | | | | | | | | 12 4-mo. | 18 4-mo. | | |
| D. L. Jones | Superintendent | Substation No.12 | x | | | | | | | | Col.of Commerce | | 6 | 6 | | |
| | | | | | | | | | | | Univ. Wis.4-yrs. | | | | | |

Continuation of Personnel of Texas Agricultural Experiment Station Staff– Technical Research Workers on Full Time.

| Name | Title | Location | Present Duties | | | | Educational Training | | | | | Experience | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Research | Adm. Research | Control | Adm. Control | Teaching | Degrees B.— | Degrees M.— | Degrees Doctor's | Inst. Conf. Highest Deg. | Major for Advanced Deg. | No. Years in This Station | No. Years in Research Work | No. Years in U. or College Wk. Other Than Res'h. | No. Years in Educational Wk. Below U. or College Grade |
| E. M. Peters | Superintendent | Substa. No. 14 | x | | | | s | | | | Tex. A.& M.C. | | 6 1-2 | 6 1-2 | | 1 |
| D. H. Bennett | Veterinarian | Substa. No. 14 | x | | | | | | | DVM. | Pa. | | 6 1-2 | | | |
| O. L. Carpenter | Shepherd | Substa. No. 14 | x | | | | | | | | Tex. A.& M.C. | | 3 | 3 | | |
| W. H. Friend | Superintendent | Substa. No. 15 | x | | | | s | | | | Tex. A.& M.C. | | 1-2 | 1 1-2 | | 1-Voc-Teach. |
| Teaching Staff Carrying Cooperative Projects in the Station—Not on Station Staff. | | | | | | | | | | | | | | | | |
| S. W. Bilsing | Prof. Entomology | | x | | | | x | | | | | | | | | |
| W. L. Stangel | Prof. Ani. Husb. | | x | | | | x | | | | | | | | | |
| F. A. Buechel | Prof. Agr. Eco. | | x | | | | x | | | | | | | | | |
| G. W. Adriance | Asso. Prof. Hort. | | x | | | | x | | | | | | | | | |
| W. E. Garnett | Prof. Rural Sociology | | x | | | | x | | | | | | | | | |
| G. P. Grout | Prof. Dairy Husb. | | x | | | | x | | | | | | | | | |
| R. C. White | Asso. Prof. Rural Sociology | | x | | | | x | | | | | | | | | |
| H. V. Geib | Asst. Prof. Agron. | | x | | | | x | | | | | | | | | |
| E. O. Pollock | Asst. Prof. Agron. | | x | | | | x | | | | | | | | | |

Continued:

Non-Technical Staff

| Name | Title | Location | Educational Training | Experience | |
|---|---|---|---|---|---|
| | | | | No. of years in This Station | No. Years in Educational Work Below U. or College Grade. |
| A. D. Jackson | Div. Publication, Chief | Main Station | High School, Normal School | 3-1-2 | 7-teaching |
| S. D. Pearce | Sec'y. Feed Control | Main Station | 3-yrs. University of Texas | 9-1-2 | 6 |
| C. A. Felker | Chief Clerk | Main Station | High School—Business Course | 12-1-2 | |
| A. S. Ware | Secretary | Main Station | High School—Business College | 16 | |
| M. P. Holleman, Jr. | Ass't Chief Clerk | Main Station | High School—Business College | 5-1-2 | |
| J. M. Schaedel | Executive Ass't | Main Station | High School—Business College | 12-1-2 | |
| C. M. Mitchell | Mailing Clerk | Main Station | High School | 2 | |
| Miss Maude Brown | Stenographer | Main Station | High School—Business College | 4-1-2 | |
| Miss Maude Creed | Registration Clerk | Main Station | High School—Business College | 4-3-4 | |
| Miss Vera Crutchfield | Stenographer | Main Station | High School—Business Course | 6-mo. | |
| Miss Gladys Dowling | Stenographer | Main Station | High School—Grad. Massey Bus. Col | 2-1-6 | |
| Miss Ella Francis | Clerk | Main Station | Business Course Baylor Belton Col. | 1-3-4 | |
| Mrs. Beulah Goen | Copyist | Main Station | High School—Business College | 2-1-2 mo. | |
| Margaret Gorzycki | Copyist | Main Station | | 4-1-4 | |
| Mrs. Velma Graham | Ass't Chem. Lab | Main Station | High School | 4-1-2 | |
| Miss Dona Newland | Clerk | Main Station | High School | 4 | |
| Miss Inez Reed | Stenographer | F. & B. No. 10 | High School—Business College | 6-mo. | |
| Miss E. M. Robertson | Stenographer | Main Station | High School | 4-1-2 mo. | |
| Miss Elisabeth Spence | Stenographer | Main Station | B. A. Degree, Texas University | 1-1-2 | |
| Miss Stella Stuart | Stenographer | Main Station | High School—Business Course | 3-3-4 | |
| Miss Rosalie Taylor | Stenographer | Main Station | High School | 1-2 | 4 |
| Miss Ruby Wheeler | Stenographer | Main Station | Tr. at Bryan Bus. Col. High School | 1-2 | |
| Miss Clara Wood | Stenographer | Main Station | High School—Business Course | 3-1-2 | |
| Miss Elizabeth C. Wood | Laboratory Ass't | Main Station | Grad. Bus. College | 9-mo. | |
| Miss Anna Mae Yardly | Copyist | Main Station | High School | 2-1-2 mo. | 6 |

Salaries of Station workers are in alignment with those paid by the other major divisions of the College for corresponding types and characters of work. It has been the policy of the research branch, however, not to adhere absolutely to a basic salary schedule, and consequently some of the workers receive slightly larger and some receive somewhat smaller salaries than indicated by the basic schedule, depending upon the amount and character of the work performed by the individual.

It should be explained that the time put in by each and every research worker is *full time*, with no relation whatever to the hours of classroom work in the teaching divisions of the College. It is significant that in this organization the entire time of all the employees is devoted to research and the administration of research. While a certain amount of control duty is shown, it should be noted that nearly all workers assigned to control work put in their entire time on that class of duty. This means that such regulatory work as is done by the Station System is administered aside and apart from research, by a separate corps of specialists, though under the immediate direction of the research agency. The tabulation further shows practically no teaching duty is performed by the regular research staff members. Summarizing the present duties of the research staff, therefore, it is apparent that the members of the staff of the Texas Agricultural Experiment Station System are devoting their full time and energy exclusively to research in agriculture.

Referring to educational training of the members of the research staff, if will be noted from the tabulation that there are the following degrees represented

| | |
|---|---|
| Ph. D. | 6 |
| D. V. M. | 4 |
| M. S. A. | 3 |
| M. S. | 12 |
| B. S. | 45 |

It is shown that the workers received their training in diverse institutions, thus indicating a lack of what might be termed "inbreeding" in educational training, and that a given man's training has been in keeping with the line of research which he is now pursuing. Summarizing the educational training of the workers, it might be stated that the research workers in the present organization have received good training at leading institutions, and that they have been selected with respect to training received along the special lines of work to be pursued.

As to experience, it will be noted that many of the men have had years of experience in research, but that they, as a rule, have had comparatively little experience in teaching or other branches of educational work. In other words, these men have specialized in research and are perhaps better fitted for this class of service than any other.

At the present time there are on the staff of the Texas Agricultural Experiment Station 48 men who devote their entire time to research, and

yet the public demand for additional lines of work has not been satisfied. If, as often claimed, a teacher should devote one-sixth of his time to research and five-sixths to teaching, and teachers were required to do all the research work of the institution, not less than 279 teachers so employed would be required in the College, which is a larger number than the College needs, as is indicated by the fact that this number is greater than the total number of teachers and research workers now employed throughout the institution. Yet it is doubtful if 279 teachers, devoting one-sixth of their time to research, would be as efficient as one-sixth of that number of workers, devoting all their time to research, because their time would not be continuous, and, therefore, their work would not be so effective.

The tabulation shows that nine teachers in the College are devoting some of their time to research projects under the terms of cooperative agreements existing.

Attention should be called to the non-technical staff, a very necessary and vital part of the organization, inasmuch as a large portion of the time of these workers is consumed by duties directly relating to research and very closely approaching a character of effort that would be classed as actual research. It will be seen that most of the members of this non-technical staff are high-school and business or commercial college graduates and many of them have had years of experience in their lines of work.

# TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

W. B. BIZZELL, President

CIRCULAR NO. 34 JULY, 1924


DIVISION OF HORTICULTURE

# THE LOWER RIO GRANDE VALLEY OF TEXAS


B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

Circular No. 34 July, 1924

# THE LOWER RIO GRANDE VALLEY OF TEXAS

by

A. T. Potts, M. S., M. S. C.,
Chief, Division of Horticulture

The College receives hundreds of inquiries annually in regard to the Lower Rio Grande Valley. In order that the information gathered in locating the citrus station might be available to prospective settlers, a part of the data upon which the Board made its decision has been summarized in the following pages.[1]

The Thirty-eighth Legislature made an appropriation for the establishment of a citrus experiment station in the Lower Rio Grande Valley of Texas. The location of the station was placed in the hands of the Board of Directors of the A. and M. College, who called upon the President of the College and the Director of the Texas Agricultural Experiment Station System for scientific information so that the new station might be located in such a manner as to best serve the needs of that section. After a close inspection of the most desirable of the numerous sites offered, the Board selected a tract of 100 acres of fine Victoria sandy loam, at Llano Grande, a switch on the Sam Fordyce branch of the St. L. B. & M. railroad and on the highway from Weslaco to Mercedes.

## *General Consideration*

The Lower Rio Grande Valley is generally understood to be the southernmost part of the state lying along the Rio Grande from the Gulf of Mexico west for 75 to 80 miles. It has a width varying from 25 to 30 miles diminishing to practically nothing. The most of this area is now subject to irrigation and would probably be greatly extended if a gravity system of irrigation were installed.

The surface of the "Valley" is nearly flat but with a gentle slope from the northwest to the southeast. The slope is said to be about 18 inches to the mile as an average but certain areas along the streams have more fall than those further away. The elevation above sea level is about 30 feet at Brownsville, 55 feet at San Benito, and 65 feet at Mercedes and at Mission.

The "Valley" floor has several levels that are generally spoken of as "lifts" in irrigation. The different levels are not clearly shown from Brownsville east to the Gulf, but westward they are more or less pronounced. This difference calls for "lifting" the irrigation water a second or third time in some areas and so adds to the cost of operation.

Owing to the flat surface, natural drainage is poor over large areas. The surface bordering the streams being higher than the inter-stream

[1]In preparing their reports for the Board of Directors, the College executives called upon the following specialists for information: A. B. Conner, agronomy; R. G. Hemphill, U. S. Irrigation Engineer; A. T. Potts, horticulture; H. H. Bennett, W. T. Carter, M. W. Beck, and B. H. Hendrickson, soils

areas, the water tends to flow away from the natural outlets. The higher areas are usually composed of coarser-textured soils and therefore have fairly good drainage. The flat areas are composed of finer-textured soils such as silty clays and clays (heavier soil) so that the downward movement of the water is slow. There being only a very slight natural slope, the land drains very slowly so that a high water-table may result. Such a condition may be largely or entirely prevented or corrected by proper drainage districts. Poor drainage of irrigated land has resulted in injury to crops near canals. This, coupled with over-irrigation, has caused considerable areas to accumulate sufficient alkali to be injurious to crops. Surface ditching and tile drains, where used, have lowered the ground water level and alkali content.

The "first bottom" of the Rio Grande overflows occasionally. The old alluvial soils away from the river bottom are also largely overflowed at times from the Rio Grande. Some levees have been constructed in places and have prevented, to some extent, damage from overflows. Definite plans have also been made by Hidalgo County, and at this time are being considered in Cameron County, for permanent flood control.

### *Soils*

The soils of the Lower Rio Grande Valley range from light sand to heavy clay. For the most part the color is dark though there are restricted areas having a brownish, redish, or grayish cast. Detailed soil surveys of Cameron and Hidalgo counties are now in course of preparation and should be available within a few months. The soils of the Valley are very productive and suited to a wide range of crops. Contrary to the usual opinion, some of the heavier soils have proved to be especially adapted to vegetable crops. Citrus fruits are found growing well upon nearly all types. Special attention is given to root stocks and drainage upon the heavier soils. General farm crops are grown extensively upon all the types of agricultural land.

W. T. Carter has made the following classification of Valley soils according to origin and position:

1. Flat lands of the Coastal Beach, including dune sand and adjacent prairie, whether marsh or semi-marsh in character.
2. Recent alluvial soils, or first bottom lands along the Rio Grande.
3. Old Alluvial soils of the Rio Grande delta.
4. Coastal prairie soils.

The *flat lands of the Coastal Beach* belong mainly to the Lomalto series and are not considered as agricultural lands at this time.

The *recent alluvial soils* along the Rio Grande are not extensive. They have fairly good drainage and are productive. They are of the Rio Grande soil series and occur only as narrow strips along recent channels.

The *old alluvial* soils of the Rio Grande delta occur in a fan-shaped area some 10 or 15 miles wide near the Gulf and extend up the river or

westward, in an ever narrowing band from near Harlingen to Sam Fordyce. In Southern Hidalgo County, before reaching Sam Fordyce, these soils appear to take a first bottom position along the Rio Grande several feet below the Coastal prairie bench. East of Hidalgo County the old alluvial soils merge imperceptibly into the Coast Prairie soils with little change in topography.

There are several soil series in this area. Laredo, Cameron, and two or three new series. They are naturally very fertile, but some are not susceptible to profitable agricultural development under present drainage conditions. The Laredo silty clay loam produces good yields of all the crops grown in this region and is not difficult to work. The Laredo clay is poorly drained and more difficult to cultivate. The Cameron soil and the soils of the new series are heavy, poorly drained, dark soils but productive when properly handled.

The soils of the coast prairie are of two series principally; the Victoria series and the Brennan series. These two soil types are very much alike. The Victoria soils are darker in color, as a general thing, than the Brennan. The Brennan contains more lime and probably has less organic matter.

The Victoria soils occur extensively from Harlingen to the eastern part of Texas along the Coast Prairie. The Victoria fine sandy loam occurs extensively in northern Cameron and eastern Hidalgo county. It is a brown fine sandy loam, underlaid at 6 to 15 inches by a brown or grayish clay or clay loam which is penetrable, though not porous or leachy. Drainage is fairly good. Excellent crops of all kinds suited to the region were found growing on this soil. All tests for alkali showed a very small amount.

The Brennan series of soils occur extensively in Hidalgo County. They are light brown to grayish in color and have clay or clay loam subsoil gray in color and are quite calcareous. They frequently have poorer drainage than the Victoria soils. The fine sandy loam and the loam of this series seem especially adapted to citrus fruits, and produce good yields of all other Valley crops. As a rule this series shows very low alkali content.

The Victoria series of soils represent the largest area in the Valley followed probably by the Brennan series. Of each of these the fine sandy loam phase is most extensive.

### *Climatic Conditions*

The average rainfall at Brownsville for a period of fifty years is 24.15 inches; at Raymondville for a period of ten years, 24.07 inches; at San Benito for two years, 26.36 inches; at Harlingen for four years, 22.71 inches; at Mercedes for eight years, 21.80 inches and at Mission for two years, 9.85 inches. These records have not extended over a sufficently long time to be dependable except in the cases of Brownsville, Raymondville, and perhaps Mercedes. Taking the record of annual precipitation

at Brownsville for the fifty-year period and interpolating the annual rainfall at San Benito, Harlingen, Mercedes, and Mission, based on the records for the year 1922, we arrive at an estimate of the rainfall which seems to be quite accurate in its general application to the region. These figures are as follows, including Brownsville for fifty years and Raymondville for ten years:

| | |
|---|---|
| Brownsville, | 24.15 inches |
| San Benito, | 21.92 inches |
| Harlingen, | 22.15 inches |
| Raymondville, | 24.07 inches |
| Mercedes, | 16.91 inches |
| Mission, | 14.38 inches |

These results show that the rainfall is approximtely 24 inches along the coast line and decreases rapidly westward, the 20-inch line being located approximately at Mercedes.

The Atlas of American Agriculture, United States Department of Agriculture, Part 2, on climate, prepared by the Weather Bureau in 1922, in discussing precipitation and humidity, approximately corroborates these figures, arriving at an estimate of the rainfall from figures taken from a large number of stations at different points and for different numbers of years. It shows that the 20-inch rainfall line runs approximately north and south and passes near Mercedes.

The distribution of the rainfall is a matter of great importance to the agriculture even in an irrigated section. The publication referred to above shows that the rainfall in the Lower Rio Grande Valley, ranging from 12 to 15 inches, comes within the average warm season, that is, from April to September. The average winter precipitation (December, January, and February) is two to four inches. The average spring precipitation (March, April, and May) is four to six inches in the western part of the Lower Valley, and six to eight inches along the eastern coast line. The average summer precipitation (June, July, and August) is six to eight inches in the Central Valley,—four to six inches elsewhere. The average fall precipitation (September, October, and November) is from six to eight inches, except along the coast line, where the precipitation runs from eight to ten inches during this period.

The precipitation in the region is quite variable, as is shown by the 1922 rainfall at Brownsville, amounting to 38.69 inches, as compared with the 50-year average of 24.15 inches.

The humidity of the region is of importance to the agriculture of the section, not only in its relation to crop production, but as well in the relation of comfort to animal life. Much of this region has the humidity common to the Gulf Coast at all seasons of the year, but in the western part of this region more distant from the Gulf Coast the humidity is somewhat less, but even there it is greater than that commonly found in Central Eastern Texas.

Hail is very rare in the Lower Rio Grande Valley.

Frost is liable to occur every year in the western part of the Valley, but at Brownsville, according to the Atlas of American Agriculture, Part 2, Section 1, "Frost and the Growing Season," it is liable to occur about one year out of two. Frost is highly variable in the Lower Rio Grande Valley, as it is all through the South.

The length of the growing season in the whole of the Rio Grande Valley is comparable with the length of the growing season in Florida.

The prevailing winds for the Rio Grande Valley are quite consistently from the southeast.

The mean temperature of the Lower Rio Grande Valley is 72 to 74 degrees, being influenced by the winds, which come from the Gulf.

The southeast winds are more effective near the coast, so that that region is cooler in summer and slightly warmer in winter than points up the Valley. This difference of a few degrees in winter temperature is to be considered in the production of crops tender to cold.

### *Cold Periods*

With our present knowledge it seems that the occasional cold spells that visit the Lower Rio Grande Valley are the limiting factor in citrus production. This area is as favored in this regard as the Central citrus area of either Florida or California. The temperature data shown in the accompanying charts were compiled from the records of the Weather Bureau and cover a sufficient period of time to be dependable.

Eustis is in Lake County, Florida, in the lake region so famous for its citrus production. Redlands, California, is in the southwest corner of San Bernardino County, 60 miles east of Los Angeles. Brownsville is in Cameron County and a little east and south of the present citrus center of Texas.

A study of these tables should be of interest to any one engaged in or thinking of becoming engaged in the growing of winter vegetables or subtropical fruits. For a period of 31 years, the Eustis records show a temperature of 32° F. or lower, 159 times, or an average of 5.12 times per year. The 16-year record for Redlands showed 32° F. or below, 218 times or an average of 13.62 times per year. The 28-year record for Brownsville showed a temperature of 32° F. or below, 101 times or an average of 3.52 times per year. From the standpoint of actual freedom from frost, it would seem that the Lower Rio Grande Valley is more favored than either of the two areas compared.

On the other hand, neither of the sections mentioned has had as severe cold periods as the Texas area. On February 13, 1899, the temperature at Brownsville dropped to 12° F. and it is said every citrus tree in the state, except those having protection, was killed to the ground. This same cold wave gave Eustis 17° F., which lacks only 1° of being the coldest period there. In December, 1894, Eustis reported 16° F. and in February, 1895, the same. This double freeze killed practically all citrus in the state and

moved the center of the industry many miles to the south. The Redlands office shows January, 1913, had ten days with a temperature of 32° F. or lower. The lowest temperature was recorded as 18° F. on January 7.

Not only does the absolute minimum have a bearing upon the injury, but the duration of the cold has a decided effect. The Texas cold period of February, 1899, lasted from February 7 to February 14 with several very severe nights. The general weather conditions following a freeze affect the recovery of the crop. The Satsuma section of southern Alabama is thought to have been more severely damaged during the past winter by continued cold following a severe freeze than by the freeze proper. An early freeze in the fall is usually more injurious than the same temperature later when the fruit has been harvested and the trees are less active.

## A COMPARISON OF THE DAYS WITH TEMPERATURE 32° OR BELOW IN THE CITRUS AREAS OF CALIFORNIA, FLORIDA, AND TEXAS

### *Eustis, Lake County, Florida*

**1892**—Jan. 4, 30°. Jan. 8, 32°. Dec. 28, 31°. Dec. 29, 30°. **1893**—Jan. 7, 28°. Jan. 11, 31°. Jan. 14, 26°. Jan. 16, 31°. Jan. 17, 26°. Jan. 21, 31°. Jan. 22, 31°. Mar. 5, 30°. **1894**—Dec. 28, 31°. Dec. 29, 16°. Dec. 30, 21°. **1895**—Jan. 1, 29°. Feb. 8, 16°. Feb. 9, 21°. Feb. 10, 29°. Feb. 14, 29°. Dec. 6, 30°. Dec. 14, 31°. Dec. 31, 32°. **1896**—Jan. 5, 29°. Jan. 6, 32°. Feb. 18, 32°. Feb. 22, 30°. **1897**—Jan. 7, 32°. Jan. 28, 25°. Jan. 29, 25°. **1898**—Jan. 2, 25°. Jan. 3, 25°. Feb. 2, 28°. Dec. 12, 32°. **1899**—Feb. 9, 27°. Feb. 13, 17°. Feb. 14, 17°. Feb. 15, 32°. Mar. 8, 28°. Dec. 30, 31°. **1900**—Jan. 2, 30°. Jan. 3, 23°. Jan. 4, 30°. Jan. 30,29°. Feb. 2, 31°. Feb. 18, 24°. Feb. 19, 29°. **1901**—Feb. 24, 31°. Feb. 25, 31°. Mar. 7, 31°. Dec. 18, 31°. Dec. 19, 29°. Dec. 21, 23°. Dec. 22, 29°. **1902**—Jan. 13, 32°. Jan. 14, 27°. Jan. 23, 32°. Dec. 27, 28°. Dec. 28, 27°. **1903**—Jan. 13, 31°. Feb. 18, 31°. Nov. 28, 26°. Dec. 27, 30°. **1904**—Dec. 29, 32°. Dec. 30, 30°. **1905**—Jan. 5, 27°. Jan. 8, 29°. Jan. 9, 30°. Jan. 17, 30°. Jan. 26, 20°. Jan. 27, 21°. Jan. 28, 21°. Jan. 29, 28°. Feb. 16, 29°. **1906**—Mar. 1, 32°. Dec. 24, 25°. Dec. 25, 26°. Dec. 27, 24°. **1907**—Dec. 5, 32°. **1908**—Jan. 15, 30°. Jan. 25, 29°. Feb. 3, 29°. Feb. 21, 30° **1909**—Jan. 31, 28°. Feb. 1, 25°. Dec. 27, 31° Dec. 30, 22°. Dec. 31, 22° **1910**—Jan. 1, 30°. Jan. 23, 28°. Jan. 30, 32°. Feb. 2, 31°. Feb. 14, 28°. Dec. 3, 30°. Dec. 4, 32°. Dec. 8, 31°. Dec. 9, 32°. Dec. 22, 29°. **1911**—Jan. 5, 29°. Dec. 1, 31°. **1912**—Jan. 15, 32°. Jan. 16, 30°. Jan. 17, 30°. Jan. 18, 32°. Feb. 5, 31°. Feb. 6, 31°. Feb. 7, 31°. Feb. 9, 31°. Feb. 10, 32°. Feb. 23, 32°. **1913**—None. **1914**—Nov. 21, 28°. Dec. 12, 28°. **1915**—Mar. 23, 31°. Mar. 25, 32°. Dec. 1, 32°. Dec. 15, 31°. Dec. 23, 30°. **1916**—Feb. 15. 32°. Feb. 16, 30°. Feb. 20, 31°. Mar. 17, 31°. Dec. 17, 32°. **1917**—Jan. 12, 31°. Feb. 3, 22°. Feb. 4, 20°. Feb. 6. 28°. Feb. 7, 28°. Feb. 11, 32°. Nov. 25, 31°. Dec. 10, 28°. Dec. 11, 29°. Dec. 15, 30°. Dec. 30, 30°. Dec. 31, 23°. **1918**—Jan. 1, 25°.Jan. 2, 23°. Jan. 4, 23°. Jan. 5, 25°. Jan. 8, 32°. Jan. 10, 32°. Jan. 13, 29°. Jan. 14. 26°. Jan. 20, 32°. Jan. 24, 30°. **1919**—Jan. 4, 31°. Jan. 5, 30°. Jan. 6, 27°. Jan. 7, 32°. Feb. 11, 30°. **1920**—Jan. 5, 31°. Jan. 6, 32°. Feb. 17, 28°. Feb. 28, 30°. Mar. 2, 28°. Mar. 7, 32°. Mar. 8, 32°. 1921—None. **1922**—Jan. 29, 30°. Feb. 8, 32°. **1923**—Feb. 19, 29°.

*Redlands, California*

**1906**—Mar. 1, 29°. Apr. 2, 32°. Nov. 19, 29°. Nov. 20, 31°. Nov. 23, 31°. Nov. 25, 28°. Nov. 27, 31°. Nov. 28, 32°. Nov. 29, 29°. Nov. 30, 29°. Dec. 1, 30°. **1907**—Jan. 1, 28°. Jan. 2, 27°. Jan. 3, 30°. Jan. 19, 30°. Feb. 27, 32°. **1908**—Feb. 14, 29°. Nov. 24, 31°. Nov. 28, 32°. Nov. 29, 31°. Dec. 14, 31°. Dec. 18, 25°. Dec. 19, 28°. Dec. 20, 30°. Dec. 23, 29°. Dec. 24, 32°. **1909**—Jan. 24, 32°. Feb. 23, 32°. Mar. 12, 30°. Dec. 4, 26. Dec. 5, 31°. Dec. 6, 30°. Dec. 18, 28°. Dec. 19, 27°. Dec. 24, 30. Dec. 25, 32°. Dec. 26, 30°. Dec. 27, 32°. **1910**—Jan. 3, 32°. Jan. 4, 32°. Jan. 5, 27°. Jan, 6, 25°. Jan, 7, 28°. Jan. 8, 30°. Jan. 13, 32. Jan. 18, 30°. Jan. 19, 28°. Feb. 3, 27°. Feb. 4, 30°. Feb. 16, 31°. Feb. 17, 31°. Feb. 18, 31°. **1911**—Jan. 1, 29°. Jan. 12, 30°. Jan. 13, 30°. Feb. 17, 31°. Feb. 28, 32°. **1912**—Jan. 1, 32°. Jan. 3, 28°. Feb. 26, 30. Dec. 6, 32. Dec. 16, 32°. Dec. 21, 31°. Dec. 23, 31°. Dec. 25, 32°. Dec. 26, 29. Dec. 27, 29°. Dec. 28, 31°. **1913**—Jan. 5, 31°. Jan. 6, 22°. Jan. 7, 18°. Jan. 8, 24°. Jan. 11, 28°. Jan. 12, 27°. Jan. 21, 27°. Jan. 22, 30°. Jan. 23, 31°. Jan. 24, 30°. Feb. 20, 28°. Mar. 1, 32°. Mar. 25, 32°. **1914**—Dec. 13, 31°. Dec. 14, 29°. Dec. 15, 30°. **1915**—Jan. 17, 30°. Jan. 18, 32°. Feb. 21, 32°. Nov. 14, 32°. Dec. 16, 29°. Dec. 17, 30°. Dec. 27, 31°. Dec. 30, 32°. Dec. 31, 27°. **1916**—Jan. 7, 32°. Jan. 11, 29°. Jan. 12, 27°. Jan. 13, 30°. Jan. 30, 31°. Jan. 31, 28°. Nov. 13, 31. Nov. 14, 29°. Dec. 7, 31°. Dec. 8, 27°. Dec. 9, 28°. Dec. 10, 31°. Dec. 17, 31. Dec. 21, 31°. Dec. 25, 30°. Dec. 26, 29°. Dec. 27, 28°. Dec. 28, 31. Dec. 30, 31. **1917**—Jan. 2, 31°. Jan. 14, 32°. Jan. 16, 32° Jan. 17, 30°. Jan. 21, 32°. Jan. 22, 30°. Jan. 23, 29°. Jan. 24, 31°. Jan. 29, 32. Jan. 30, 32. Feb. 1, 32°. Feb. 2, 32°. Mar. 13, 30°. Mar. 14, 32°. Mar. 15, 31°. Mar. 16, 32°. **1918**—Jan. 11, 32°. Jan. 21, 31°. Jan. 22, 31°. Jan. 23, 31°. Jan. 28, 32°. Jan. 29, 32°. Jan. 30, 31°. Feb. 1, 31°. Feb. 2, 32°. Feb. 19, 30°. Dec. 23, 30°. Dec. 25, 28°. Dec. 26, 31°. Dec. 27, 32°. Dec. 30, 30°. Dec. 31, 27°. **1919**—Jan. 1, 27°. Jan. 2, 25°. Jan. 3, 32°. Jan. 14, 31°. Feb. 21, 32°. Feb. 25, 31°. Feb. 26, 32. Nov. 27, 32. Nov. 28, 29. Nov. 29, 29°. Nov. 30, 31°. Dec. 13, 32°. Dec. 14, 30°. **1920**—Jan. 7, 29°. Jan. 8, 29°. Jan. 9, 27°. Jan. 10, 30°. Jan. 13, 32°. Jan. 15, 32°. Jan. 16, 32°. Nov. 18, 31°. Nov. 27, 30°. Dec. 5, 32°. Dec. 6, 30°. Dec. 7, 31°. Dec. 8, 31°. Dec. 9, 32°. Dec. 13, 30°. Dec. 20, 32°. Dec. 21, 30°. Dec. 22, 31°. **1921**—Jan. 7, 31. Jan. 8, 32. Jan. 11, 27°. Jan. 12, 27°. Jan. 13, 31°. Jan. 22, 31°. Jan. 24, 29°. Jan. 25, 32°. Feb. 8, 31°. Feb. 15, 30°. Feb. 16, 30°. Feb. 18, 32°. Apr. 6, 32°. Apr. 14, 31°. Nov. 18, 29°. Nov. 19, 31°. Dec. 8, 32°. **1922**—Jan. 4, 31°. Jan. 5, 32°. Jan. 12, 32°. Jan. 13, 31. Jan. 20, 20. Jan. 21, 23°. Jan. 22, 26°. Jan. 23, 27°. Jan. 24, 30. Jan. 25, 32. Jan. 28, 29. Jan. 29, 32°. Jan. 31, 30°. Feb. 1, 28. Feb. 2, 27. Feb. 3, 25°. Feb. 4, 27. Feb. 5, 30°. Feb. 13, 32°. Mar. 1, 28. Mar. 2, 28. Mar. 3, 32. Mar. 10, 30°. Mar. 12, 29°. Mar. 13, 32°. Mar. 18, 31°. Apr. 6, 31°.

*Brownsville, Texas*

**1893**—Jan. 19, 27°. **1894**—Dec. 28, 27°. Dec. 29, 27°. Feb. 22, 27°. **1895**—Feb. 8, 22°. Feb. 11, 24°. Feb. 14, 22°. Feb. 16, 22°. Feb. 17, 22°. Feb. 25, 25°. Feb. 7, 27°. **1896**—Nov. 29, 31°. Nov. 30, 30°. **1897**—Dec. 4, 31°. Dec. 27, 31°. Dec. 31, 30°. **1898**—Dec. 5, 32°. Dec. 6, 32°. Dec. 10, 31°. Dec. 11, 31°. Dec. 12, 32°. **1899**—Jan. 1, 32°. Jan. 2, 32°. Feb. 7, 29. Feb. 8, 24. Feb. 9, 25. Feb. 12, 16. Feb. 13, 12°. Feb. 14, 18°. **1900**—Feb. 17, 31°. Feb. 18, 27°. Dec. 29, 32°. Dec. 31, 25°. **1901**—Jan. 1, 20. Jan. 2, 28°. Jan. 16, 30°. Jan. 17, 29°. Jan. 18, 32°. Jan. 30, 32°. Feb. 12, 28°. Feb. 13, 30°. Feb. 14, 25°. Feb. 23, 27°. Nov.

14, 31°. Nov. 15, 28°.* **1902**—Feb. 1, 29°. Feb. 2, 30°. **1903**—Feb. 16, 26°. **1904**—Jan. 28, 32°. **1905**—Jan. 14, 32°. Jan. 15, 30°. Feb. 13, 22°. Feb. 14, 28°. **1906**—Jan. 23, 30°. Feb. 8, 32°. **1909**—Jan. 12, 28°. Jan. 13, 30°. Feb. 16, 29°. **1910**—Jan. 7, 30°. Feb. 18, 32°. **1911**—Jan. 3, 28°. Jan. 4, 21°. **1912**—Jan. 7, 31°. Jan. 8, 32°. Jan. 9, 32°. Jan. 12, 30°. Jan. 13, 24°. Feb. 4, 29°. Feb. 5, 30°. Feb. 6, 27°. Feb. 7, 30°. **1913**—Jan. 7, 30°. Jan. 8, 31°. **1914**—Jan. 31, 30°. Feb. 25, 30°. **1915**—Jan. 25, 30°. **1916**—Jan. 17, 30°. Feb. 2, 30°. **1917**—Feb. 2, 24°. Mar. 5, 31°. Dec. 30, 24°. Dec. 31, 31°. **1918**—Jan. 11, 25°. Jan. 12, 26°. Feb. 2, 31°. **1919**—Jan. 3, 32°. Jan. 4, 24°. Jan. 5, 30°. Jan. 9, 30°. Dec. 28, 32°. Dec. 29, 32°. **1920**—Mar. 8, 32°. Nov. 16, 32°. Dec. 28, 32°. Dec. 29, 32°. **1921**—None. **1922**—Mar. 1, 31°. Mar. 2, 32°. Mar. 3, 32°. Mar. 4, 31°. **1923**—Feb. 5, 31°. Feb. 6, 32°.

### *Irrigation and Drainage*

Where irrigation is practiced, land drainage sooner of later becomes a paramount problem. This is now true to some extent in the Lower Rio Grande Valley. Although there are no authentic records of the rise of ground water available, it would seem that the statements of old settlers as to the depth of water obtainable in wells should be considered. This together with the fact that water was occasionally encountered in six-foot soil-sampling, would indicate that the water table is slowly rising in some sections of the irrigated area.

This entire area, having very little slope, will have to receive careful attention to its drainage. Being so closely associated with irrigation, drainage should be considered at the same time.

The following paragraph is summarized from a report by Mr. R. G. Hemphill, U. S. Irrigation Engineer.

From a standpoint of irrigation and drainage, the selection of a piece of agricultural land should be based upon the following considerations:

An adequate water supply in the river.

A right to divert that supply.

An irrigation system with pumps, canals, structures, and so forth, of proper size and fit condition to carry the water from the river to all land under the canal at all times and without delay.

Taxes and water charges which can be borne by the land.

A uniform soil which will irrigate and drain satisfactorily.

A land surface which may be brought to a uniform moderate slope.

A location with reference to main canal and lateral which will permit water to be measured and used with the least interference from others.

Satisfactory ground-water conditions and a drainage outlet conveniently near.

Proper surface drainage.

Freedom from overflow during floods.

*Several freezes in December 1901, but temperature record unreliable.

Without attempting to discuss all of these points in detail a brief statement will be made in regard to some of them.

There are so many factors affecting the amounts of water used by different crops that no definite figures can be given. The following, however, seem to be the best estimates for the conditions in the Rio Grande Valley available at this time. They are based upon reports of the Texas Board of Water Engineers and the practice of growers. The amounts are in inches and include rainfall and irrigation during the crop season.

*Water Used by Crops*

| Crop | Inches |
|---|---|
| Corn | 16—20 |
| Cotton | 14—17 |
| Sorghum | 8—10 |
| Cabbage | 16—20 |
| Lettuce | 10—14 |
| Cauliflower | 12—16 |
| Tomatoes | 14—17 |
| Beets | 10—14 |
| Carrots | 10—14 |
| Snap beans | 10—12 |
| Sugar cane | 55—60 |
| Rhodes grass | 6— 8 |
| Citrus | 35—45 |

In irrigation farming the contours of the land are of greater importance than in a non-irrigated section. On this account considerable expense is sometimes involved in preparing land for water that had not been anticipated. For best results the land should have a moderate, uniform slope of one to two feet per hundred feet. There are also found occasional small isolated areas that are too high for irrigation without an additional lift.

Variable soil will cause an unequal percolation of the irrigation water. This may cause one area to receive excess water in order to properly irrigate a less permeable area under the same furrows.

Surface drainage should receive attention. There are few areas of any extent that do not have small depressions that tend to hold water. Surface ditches on the farm and a permanent outlet for this surplus water should receive attention.

There is a flat charge made by the district upon all land within the area subject to irrigation. The charge varies somewhat with the district, but will probably average around $3.50 per acre per annum whether the land is cultivated or not. This flat rate is to cover the upkeep upon canals, pumping plants, interest upon bonds or investment, and so forth. In addition to this there is a fixed charge of about $1.50 for each irrigation. The amount of water used each time does not affect the rate. This practice

has given rise to the excessive use of water, which is a needless expense to the district and frequently a cause of loss to the growers. In the long run a system of meters and a charge for the amount of water actually used will be found most satisfactory for all interests.

The accumulation of soluble salts or "alkali" is a natural consequence of irrigation in a semi-arid region with inadequate under-drainage. These salts are brought up from deep in the soil and left near the surface as the water evaporates. The river water used for irrigation does not usually contain dangerous amounts of alkali.* At this time the areas of soil containing dangerous amounts of alkali are small. The principal deleterious salt found is sodium chloride. There seems to be little of the sodium carbonate or sodium sulphate.

Some investigators give the limit of tolerance of plants for different alkali salts in the soil as follows

| | |
|---|---|
| Sodium Sulphate | 1.00 per cent |
| Sodium Chloride | .50 per cent |
| Sodium Carbonate | .05 per cent |

There is, however, considerable variation in the tolerance of different crops to alkali.

The Bureau of Soils states "Soil containing from .60 to 1.00 per cent. of total soluble salts is almost worthless for general farming and fruit growing."

The following shows some of the results of a number of tests made on various soils in Cameron and Hidalgo Counties recently by a soil survey party using a wheatstone bridge to determine total soluble salts. They are higher than the average and in some cases were not considered as agricultural lands.

| | |
|---|---|
| *Rio Grande Soils (first bottom) | .11 to .18% |
| Laredo Soils | .08 to .26%, and in seepage spot 2.43% |
| Cameron Soils | .21 to .65%, and in seepage spot 1.09% |
| Olmito Soils (low swales) | .82 to 1.33%, and in seepage spot 1.70% |
| San Benito Soils | .30%, and in seepage spot .73% |
| Harlingen Soils | .35% |
| Victoria fine sandy loam | .15% |
| Victoria clay loam | .13% |
| Brennan loam | .06% |
| Brennan loam, a water-logged flat land near canal | .10% |

These results seem to indicate that all the soils of this region will contain too much alkali in time under conditions of irrigation without drainage, but it seems that there is less danger in the Victoria and Brennan fine sandy loams than in the heavier soils. The Rio Grande soils of

*The names of soil series (types) do not necessarily refer to any place having the same name.

the first bottom along the river also show only small amounts of alkali in the tests made, owing to overflows which keep the salts washed out and on account of comparatively fair drainage.

### *General Crop Adaptation*

There is a wide range of crops grown in the Lower Rio Grande Valley. This is due to the natural fertility of the soil, climate, and the water supply. Cotton, corn, broom corn, sugar cane, alfalfa, sweet clover, cowpeas, velvet beans, Rhodes grass, Sudan grass, the sorghums, citrus and other subtropical fruits, and practically all of the vegetables seem to find a congenial home. The strictly temperate-zone fruits such as apples and cherries, do not do well. Certain varieties of grapes, peaches, plums, apricots, and pears seem well adapted, though not extensively grown at this time.

Advantage is taken of the mild winter climate to produce such crops as cabbage, beets, carrots, onions, and lettuce which withstand a few degrees of cold. They are generally followed on the same land by cotton, corn, or broom corn, or by pepper, tomato, squash, or other summer vegetables. The cropping system used is one that keeps the land busy for the greater part of the year. This is essential with high-priced land and high overhead expenses.

Cotton, corn, the sorghums, and similar crops, give high yields of good quality, but are not generally profitable, unless more than one crop can be taken from the land in a year. High-priced land calls for crops of high unit value. At this time such crops are confined to the vegetable and citrus fruits or to specialized enterprises. Cotton, however, is a crop that fits well into most Valley cropping systems, because of its climatic adaptation and small water requirements, and will doubtless be more extensively grown.

It is thought there are about 1,500,000 citrus trees in the Lower Rio Grande Valley. The total of all citrus fruit shipments for 1923 and 1924 was about 72,000 boxes, most of which was grapefruit. Most of the trees are young, but there are some of sufficient age to indicate that the soil and climate are well adapted to this crop if properly handled.

At this time vegetables are probably the most profitable of the crops grown in the Valley. Several thousand cars of cabbage, beets, carrots, lettuce, potatoes, melons, and mixed vegetables, move out of the Valley each winter and early spring. Most of these reach the great consuming centers of the northern Mississippi Valley. Most of the vegetables are grown on rather an extensive scale so that wholesale methods of culture and harvest are used.

Poultry, dairying, swine, and other phases of livestock production are being rapidly developed and should find a place upon all properly diversified farms.

## PUBLICATIONS AVAILABLE

### Order by NUMBER

BULLETINS

No
128 Cottonseed Meal as a Human Food (Technical)—1910.
159 Steer Feeding—1913.
162 Composition and Digestibility of the Chloroform Extract of Texas Hays and Fodders (Technical)—1913.
163 Digestion Experimets on men with Cottonseed Meal—1913.
165 Ammonia-Soluble Inorganic Soil Colloids—1914.
166 Digestion Experiments with Texas Feeding Stuffs—1914.
167 Commercial Fertilizers and Their Use—1914.
169 The Total Fatty Acids and Other Ether-Soluble Constituents of Feedstuffs—1914.
170 Texas Feeding Stuffs; Their Composition and Utilization—1914.
171 Losses of Moisture and Plant Food by Percolation—1914.
172 Sudan Grass—1915.
173 The Composition of the Soils of the Texas Panhandle—1915.
174 The effect of Organic Compounds in Pot Experiments—1915.
175 Distribution and Digestibility of the Pentosans of Feeds—1915.
178 The effect of the Additions on Availability of Soil Phosphates—1915.
181 Oxidation of Organic Compounds in the Soil—1915.
182 Steer Feeding—1912.
183 Moisture Relations of Some Texas Soils—1915.
184 Cooperative Fertilizer Experiments with Corn—1908-14.
185 The Production Co-Efficients of Feeds (Technical)—1916.
186 Fattening Lambs—1916.
187 Sprays and Spraying—1916.
188 Tile Drainage—1916.
189 The Composition of Cottonseed Meal and Cottonseed—1916.
190 The Effects of Additions on the Availability of Soil Potash and the Preparation of Sugar Humus—1916.
191 The Composition of Rice and Its By-Products—1916.
192 Soils of Grayson, Lee, McLennan, Titus and Tyler Counties—1916.
195 Japanese Sugar Cane as a Forage Crop—1916.
196 Digestibility of Sugar, Starches, and Pentosans of Roughages—1916.
197 Progress Report, Substation No. 3, Angleton, Texas—1909-14.
200 Progress Report, Substation No. 4, Beaumont, Texas, 1909-14.
201 Peanut Meal and Ground Whole Pressed Peanuts for Hogs—1916.
203 The Productive Values of Some Texas Feeding Stuffs—1916.
204 The Recurving of Milo and some Factors Influencing It. (Technical)—1917.
207 Poultry Houses and Poultry Equipment for Texas—1917.
208 The Fig in Texas—1917.
209 Progress Report, Substation No. 2, Troup, Texas, 1909-14.
210 Barns for Work Animals—1917.
211 Field Experiments with Crown Gall—1913-17.
212 The Availability of Phosphoric Acid in Rock Phosphate—1917.
213 The Composition of the Soils of South Central Texas—1917.
214 Progress Report, Substation No. 1, Beeville, Texas—1910-14.
215 Progress Report, Substation No. 5, Temple, Texas—1910-14.
218 Progress Report, Substation No. 7, Spur, Texas—1909-14.
219 Progress Report, Substation No. 8, Lubbock, Texas—1910-14.
221 Progress Report Substation No. 9, Pecos, Texas—1910-14.
222 The Composition of Peanuts and Peanut By-Products—1917.
224 The Influence of Peanuts and Rice Bran on the Quality of Pork—1918.
226 Cooperative Soft Pork Investigations—1918.
227 Studies of the Harlequin Bug—1918.
228 The Influence of Peanut Meal on the Quality of Pork—1918.
229 Experiments at Substation No. 3, Angleton, Texas—1909-16.
231 The Beemoth or Waxworm—1918.
232 Mineral Requirements of Sheep—1918.
236 Grain Sorghum Improvement—1918.
240 The Utilization of Yucca for the Maintenance of Cattle—1918.
243 The Need of Texas Soils for Lime—1919.
244 Composition of the Soils of Archer, Franklin and Harrison Counties 1919.
245 Feeding Values of Certain Feeding Stuffs—1919.
247 The Chemical Composition of the Cotton Plant—1919.
258 Report of Experiments at Substation No. 4, Beaumont, Texas—1915-18.
259 Nitrification in Texas Soils (Technical)—1920.
262 The Searing Iron vs. the Knife for Docking or Detailing Lambs—1920.
263 Rations for Fattening Steers—1920.
269 Grain Sorghum vs. Corn for Fattening Lambs—1920.
270 A Study of the Black and Yellow Molds of Ear Corn—1920.
275 Spur Feterita—1921.
277 Sweet Potato Fertilizer Experiments at Substation No. 2—1921.
279 Type and Variability in Kafir (Technical)—1921.
282 Composition and Feeding Value of Wheat By-Products—1921.
286 Rice Bran for Fattening Hogs—1922.
294 Shelling Percentages in Grain Sorghum—1922.
296 Grain Sorghum vs. Corn for Fattening Baby Beeves—1922.

No.

297 An Economic Study of a Typical Ranching Area on the Edwards Plateau of Texas —1922.
305 Swine Feeding Experiments—1923.
306 Grain Sorghum vs. Corn for Fattening Lambs—1923.
307 Texas Root Rot of Cotton and Methods of its Control—1923.
308 The Sweet Potato Weevil—1923.
309 I. Fattening Steers on Cottonseed Hulls With and Without Corn.—II. The Influence of Age on Fattening Steers—1923.
310 The Interpretation of Correlation Data—1923.
311 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by range Sheep—1923.
312 Commercial Fertilizers in 1922-23.
313 Rice Bran and Rice Polish for Growing and Fattening Pigs—1923.
314 Commercial Feeding Stuffs Sept. 1, 1922 to Aug. 31, 1923.
315 Digestion Experiments with Oat By-Products and other Feeds, Report No. 7—1924.
316 The Soils of Brazos, Camp, Ellis and Washington Counties—1924.
317 Comparative Influences of Various Protein Feeds on Laying Hens—1924.
318 The Relation between Rents and Agricultural Land Values in Theory and in Practice—1924.
319 Field and Laboratory Notes on a fatal Disease of Cattle Occurring on the Coastal Plains of Texas (Loin Disease)—1924.
320 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by Angora Goats under Range Conditions—1924.
321 Cotton Variety Experiments at the Main Station—1912 to 1922.
322 Commercial Fertilizers in 1923 and 1924.

## CIRCULARS

1 Strawberries Under Irrigation in South Texas—1914.
7 Insect Enemies of Sudan Grass—1915.
19 Housing Farm Implements—1915.
18 The San Jose Scale—1916.
22 The Malvaceous Plants of Texas—1920.
26 Cost of Production; Its Relation to Price—1920.
30 The Practicability of the Milking Machine—1923.
31 Standard Fertilizers and their Use (Reprint)—1923.
32 Cotton Boll Weevil Control in Texas—1924.
33 Texas Agricultural Experiment Station System—1924.

## ANNUAL REPORTS

25th for 1912; 26th for 1913; 27th for 1914; 28th for 1915; 29th for 1916; 32nd for 1919.

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3-25-15M

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

W. B. BIZZELL, President

CIRCULAR NO. 35 February, 1925

DIVISION OF ENTOMOLOGY

# SUGGESTIONS ON QUEEN REARING

B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

## SYNOPSIS

While producing queens for use in experimental work various systems and methods of queen rearing were practiced. Modifications have been made and gradually a fixed system has been developed which makes production of pedigreed queens convenient and easy, giving to the breeder or beekeeper greater opportunity for improving his stock through selection and line breeding.

Selection of a colony from which the breeding queen shall be produced is based on the disposition and honey-gathering ability of the desired queen's sisters. Productiveness is judged by the ability of the queen in the colony selected to produce 16 to 20 frames of brood.

The cell-building colony is so manipulated as to cause it to approximate as nearly as possible the condition of a colony preparing to swarm, and then of a colony that has swarmed.

In the preparation of cell frames, wooden cell-cups are attached to cross bars. The royal jelly, sometimes difficult to obtain, may be taken when abundant, and stored, even from one season to another, and then diluted and used for priming queen cells.

A chronological chart shows the life conditions that take place and the manipulations to be practiced in a mating colony during a season. At the time when observation is made to determine if the queen is laying, the brood of the queen occupying the mating colony just previously is observed and the purity of her mating recorded.

The natural enemies which frequent queen yards may be controlled with little difficulty and the loss of many queens prevented.

A man with fifty colonies of bees with which to run a queen yard should produce one hundred queens every twenty-one days.

Circular No. 35 February, 1925

# SUGGESTIONS ON QUEEN REARING

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A. H. Alex, B. S., Queen Breeder

During the course of the investigations being conducted at the Apicultural Research Laboratory of the Texas Agricultural Experiment Station more than eleven hundred well bred queens have been raised. The object of this production has been to obtain data on the process of queen development and on the improvement of stock by selection, cross breeding and line breeding. In connection with this work, various methods of queen rearing have been tried. In attempting to minimize labor and expense and get the largest returns in number of queens produced, the existing methods were modified and a new system devised using a one-brood method. In this system only the brood of the last queen to occupy the mating colony emerges during the presence of the new or succeeding queen. Notes are taken on the purity of mating of the last queen as indicated by the emerging brood, and at the same time observations are made on the laying of the new queen.

The success obtained in producing laying queens has been such that the authors feel justified in presenting the details of this system to the beekeepers of Texas. It can be used by those who wish to produce queens in quantity or adapted to use of those who desire to produce queens for their own apiaries or to experiment in queen breeding.

The special publications on this subject are few in number, most of the information on queen rearing being found in short articles widely scattered through beekeeping journals and general works on beekeeping. This literature has been a source of the material from which this system was devised.

The method of procedure which is used at the Laboratory has been given without the discussion of possible variations, as the use of any variation in method might produce conditions that would render the system unsuccessful. If the queen breeder tries this system and it does not fit his conditions he has the basis on which to make such adaptations as will meet his needs.

The raising of queen bees is interesting and profitable work. It will well repay any beekeeper owning one hundred or more stands of bees to maintain a small queen yard, as this will enable him to secure a stock of young well bred queens at the time he needs them.

There is no division of agricultural science that requires closer adherence to a system and more attention to the minute details than does queen rearing. A single wrong step or a delay of an hour in an operation may upset the routine and interfere with the production of a whole set of cells. Commercial queen breeding on a large scale should not be attempted by anyone who has had no experience. Every year brings on a new crop of commercial queen breeders, but only a very few remain in the business for years. The failure is usually due to the fact that the breeder does not adhere to system in his work and is negligent in his business methods.

## SELECTION OF YARD SITE

Commercial queen rearing is a speeding up of the natural method used by the bees. It is made necessary by the demand for young queens to be used in swarm control, for increasing artificially the number of colonies, and for stock improvement. Every step taken in the process must be carried out as nearly as possible under the same conditions as exist in the hive when the same operation occurs naturally.

**Location**: The first and greatest requirement of a queen yard is accessibility. It must be so located that the operator can be there, no matter what the weather, at the required time. If one can choose his location he should follow the teachings of nature. Cell-building occurs naturally and to the greatest extent during a time of light but continued honey flow. So in choosing a location, select, if possible, a place where no heavy flows occur but where light flows continue all summer. If possible it should be located at a distance of several miles from other apiaries, as an aid in securing pure mating. Bee trees and stray swarms in the neighborhood should be destroyed or cared for properly. A water supply is a necessity.

## EQUIPMENT

**House**: A house is a necessity. This should be large enough to provide storage for extra equipment, as well as working space; about 16 x 24 feet is a convenient size. The house should be well constructed, bee-and wind-tight, and provided with plenty of windows and a stove. It should

Figure 1 –When a division board is used, two mating colonies can occupy one hive body. The inner cover is sawed through lengthwise and strips are nailed to the bottom board allowing entrance to each side but at opposite ends

also be provided with a work bench and carpenter vise, a table, and a desk for business papers and records. The best table is one about 2 1-2 feet wide by 5 feet long, high enough to work at when standing, strong in construction yet not so heavy but that it may be moved easily so as to take advantage of the light. All of the transferring of larvae should be done in the house to protect the young brood from cold in spring and from heat in summer. A stove is necessary during cool weather. The temperature in the room should never be below 80 degrees F. when one is transferring larvae or when queen cells are being handled.

**Breeding Colonies:** These should be housed in two-story ten-frame hives. Add supers as needed. The action of these large normal colonies will often influence the beekeeper's opinion of a breeding queen. When a breeding queen is eliminated the hive can be used as a cell-builder until a new queen is put into it.

**Cell Building Colonies:** These must be strong colonies headed by young queens and housed in two-story ten-frame hives. The reason for the ten frames will be found under "Operation". There should be one cell-building colony for every 35 cells needed at one time, so that a number of such colonies must be at hand from which to make a selection. These colonies, though divided later for the process of cell-building, are regarded as units throughout the season, for they are returned to their original size and condition at intervals of about six weeks.

**Mating Hives:** These are standard eight-frame hives with metal roof covers. The hive body is divided into two parts of four frames each by a tight board division nailed into place; the inner cover is sawed through lengthwise so that either side can be opened independently. The bottom

Figure 2—Frame with cross bars showing queen cells ready to be transferred to mating colonies

board has additional strips nailed to it so as to allow an entrance to each side but at opposite ends (See Figure 1). The advantages of this mating hive are the ease of manipulation of frames and the fact that upon the removal of the division board the two parts can be united into one colony for the winter.

**Cell Frames:** Use the standard brood frame. Fasten in three cross bars: thin bottom bars cut to the desired length are best. These should have only one nail in each end so that the bars can be turned when transferring is in process. These three bars should be one inch, three and one-fourth inches, and five and one-half inches, respectively, from the bottom side of the top bar (See Figure 2).

**Nursery Frames and Cages:** Use the standard sizes sold by the dealers. While they are not altogether satisfactory they fill the place better than many so-called improved forms (See Figure 3).

Figure 3—Carrier for cell protectors in foreground, spiral cell protectors and nursery cages; nursery cages in frame in background

**Transferring Tools:** The tools needed are several transferring needles, a jelly spoon, a small heavy dark-colored glass container for the diluted royal jelly, several heavy colored-glass salve jars for storing royal jelly, and also a few medicine droppers (See Figure 4).

## OPERATION

**Selection of Breeder:** After the breeding yard has been put in shape, the vital step in queen raising is the selection of a colony from which the breeding queen shall be produced. Not only the queen, but the workers of the colony, must be considered. When choosing the colony investigate the following points:

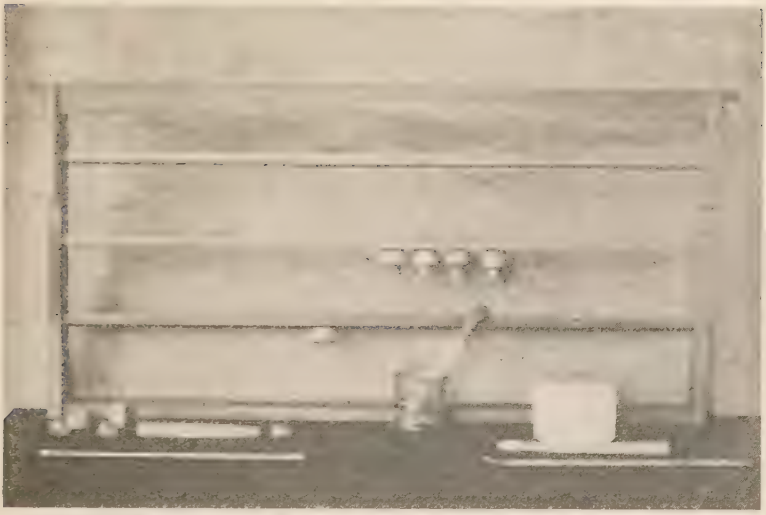

Figure 4—Frame partially prepared for cell-building colony; wooden cell-cup holders, wax cups, cell stick, jar for mixing royal jelly and water, medicine dropper, jar for storing royal jelly, transferring needles and jelly spoon are shown

Color: Since there is no such thing as a standard color for any race of bees, the queen breeder can choose the color he likes, and by careful selection he can in a few years establish a well-defined strain of his chosen type. He must see that the worker bees in the chosen colony are uniform in color.

Disposition: In judging for disposition the workers must be considered. They should be gentle on the combs when the hive is worked and not inclined to "run" or "boil" over. It is to be remembered, however, that the ability to protect the hive is an asset in bees. Colonies that are too gentle seldom produce much honey, as they are the constant victims of predacious insects, animals, and sneak-thieves. In fact, beekeepers living in the suburbs of large cities or in locations far from houses are breeding bees that are "stingers" to obviate the loss of honey and of whole colonies by theft.

Productiveness: This is judged by the performance of the queen in the colony selected. It is desirable to use a young breeding queen before she has had time in which to make a record for egg-laying and no breeding queen should be chosen whose mother did not produce 16 to 20 frames of brood in the period of her maximum egg-laying ability and maintain this peak for some time.

Honey-Gathering Ability: This may be judged by the activity of the workers produced by the queen's mother. These workers should be the kind that start work early in the morning, go directly from and return directly to the hive and take advantage of every honey flow. In fact, the colony must be of a very superior type.

Other Characteristics: There are many other characteristics that might be discussed, but because their value is largely a matter of personal opinion they are omitted.

**Breeding Queen's Colony:** The breeding queen should be the head of a colony in a ten-frame, two-story hive. She should be given all the attention and aid possible. This colony should be located near the house, so there will be no chilling or overheating of larvae in carrying combs back and forth. It should stand in a well-drained spot and where an umbrella or canvas can be used on rainy days.

**Figure 5—A suitable colony to select for a cell-builder is one that has much brood and a heavy population of bees**

**Preparation of Cell-Building Colony:** The first active step in the process of queen raising is the preparation of the cell-building colony (Figure 5). The object is to put a colony of bees in as nearly as possible the condition of a colony preparing to swarm. The following extra equipment is necessary: a super or hive body with wire cloth fastened over the bottom, a bottom board, and a cover. Select for the cell-builder a colony that has much brood in both stories and a heavy population of bees. Place the extra bottom board about three feet distant and facing the same way as the cell-builder. The wire-bottomed body or super is then placed on this bottom board screen downward. Now divide the cell-building colony, placing one body on the super or hive body with the screened bottom (Figure 6). In this portion of the cell-building colony put the large proportion of unsealed brood, the queen, and the bees which adhere to these combs. The object of the screen is to prevent the bees from returning to the old stand and, by providing room and ventilation during this confinement, to avoid

Figure 6—Give a large proportion of unsealed brood and the queen to the new colony; the original portion of the cell builder should have a large amount of sealed brood, an abundance of young bees, and no queen

smothering during hot weather. After three days the screened body is removed and the entrance arranged to suit the weather. By this time the bees will be fairly accustomed to their new location and little drifting will occur. In the hive body on the original stand put nine frames of comb arranged as follows: first or outside comb, honey and pollen; second, third and fourth, sealed brood; fifth, unsealed brood; sixth and seventh, sealed brood; eighth, honey and pollen; and ninth, an empty comb (Figure 7). All the bees adhering to these combs should be left on them. These bees with the field force should be equal to a strong colony. If these bees do not crowd the hive body, additional bees from the queenright portion should be added. The queenright portion need have only sufficient bees to take care of its brood and queen. This arrangement puts the queenless portion on the original stand in a condition similar to that which exists in a hive that has just swarmed, i. e., no queen, an abundance of young bees, a large amount of sealed brood, and very little unsealed brood. The frame of unsealed brood in the center is to attract the young bees to the center of the hive. Give this colony a five pound can-feeder of sugar syrup, one part of sugar to one part of water, at the time the cell-builder is prepared and refill the feed can as often as the bees take the syrup. The feed can is placed in an empty super as shown in Figure 8.

**Preparation of Cell Frames:** Three days after its preparation the cell-builder is ready to receive the cells. The first step in this process is to fasten the wooden cell-cups to the cross bars of the cell frame. This is done by laying the frame flat on the table, turning the bars flat with the

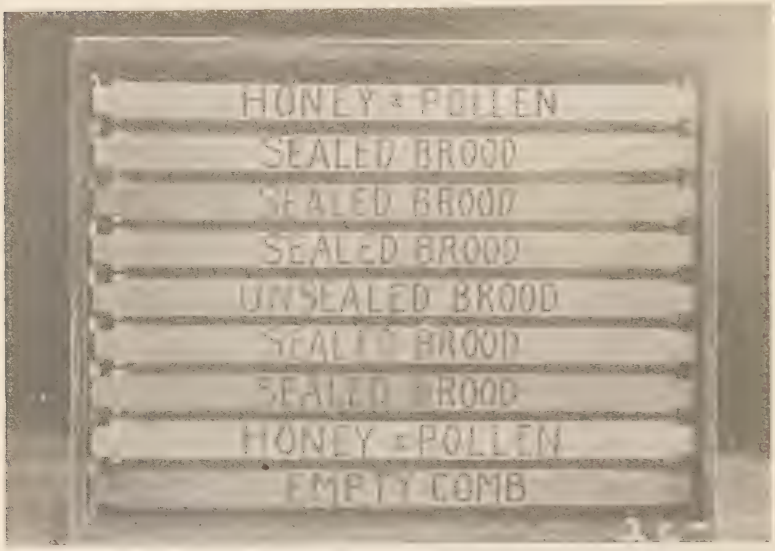


Figure 7—Arrangement of frames for cell-building colony

table-top and sticking the wooden cell-cups to the bar with a small piece of soft beeswax or by dipping the end of the cups in molten wax. Place 12 or 16 cells to each cross bar. Let the distance between these cell-cups be about 7-8 of an inch from center to center. Commence about 2 inches from the end of the bar and by using the spacing and number given above, a 2-inch space is left at the other end. Four years of experience have shown that it does not pay to put cells nearer the ends of the bars. In early spring, use not more than 12 cells on a bar. As the season advances,

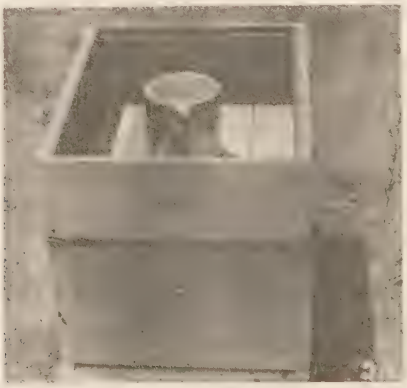

Figure 8—When the cell-building colony is prepared, give the bees a five-pound can feeder of equal parts sugar and water

the number may be increased from 14 to 16 cells (see Figure 2). Now fasten the wax cells into the wooden cell-cups by pushing the former into place with a small piece of wood about the size of a lead pencil, which has the end cut to fit the inside of the wax cell. When the wax cells are in place, they are ready to receive the royal jelly.

**Royal Jelly:** Well developed queen cells will be found on some of the combs in the cell-builder. Remove the larvae and scrape out the royal jelly with the steel jelly spoon. Be sure and find every queen cell and take all the jelly, storing it in a small opaque jar. There are times in mid-summer when it is very difficult to obtain this jelly, but with this method of storing, it may be kept from one season to another. Should it become dry, moisten with water and it will serve as well as when first taken from a cell.

**Priming Queen Cells:** After procuring the royal jelly, take a small amount, about one-half teaspoonful, which is enough for one frame, and put it into a small glass jar. This container should be a small wide-mouthed jar, dark in color and having a capacity of about two fluid ounces. Put in the same amount of water with the aid of a medicine dropper and mix thoroughly. Then add more water but not so much that when the cell is turned into its natural position the diluted jelly will run out. A drop of this jelly mixture may now be placed in each cup of the frame by means of the medicine dropper.

**Transferring Larvae:** Remove from the breeding colony a comb that has a large number of newly hatched larvae. After the bees have been carefully brushed off, the comb is carried into the house. Then, while resting the comb on edge near the cell frame, a tooth pick with the end slightly bent or a transferring needle is used for removing a larva from its parent cell to one of the cells just prepared. Larvae that are just beginning to show the larval form are best. After all the cells are filled, carefully pick up the cell frame and turn the cell bars so that the cells have the opening pointing directly downward. This frame is then placed in the cell-building colony, occupying the space formerly filled by the frame of unsealed brood, which is now removed. Frames thus removed are placed in a partly-filled hive body on some colony where they will receive proper care.

**Emergency Cells:** Four days after starting these cells, prepare and start a second set, using only two cross bars. These are the emergency cells to take the place of failures among the cells or virgins of the first lot. When the emergency frame is ready, place it in the same cell-builder so that there is a comb of sealed brood between it and the first frame of cells. At this time again look over the combs and remove any stray queen cells.

**Preparing Mating Colonies:** Ten days after the cells are started they are ready to put into the mating colonies; so on the ninth day the mating colonies should be made up. Where possible, it is well to make up these colonies from an apiary at a distance from the queen yard. Each colony should have three frames, one with some pollen and honey, one with much honey, and one with mostly sealed brood. There should be bees enough

to cover the three frames. As the operator wishes to know constantly its condition, each mating colony should be numbered and the condition recorded.

**Indicators:** A system of markers is used in order to tell at a glance the condition of the mating colony at the last examination without the necessity of referring to notes. Almost every beekeeper devises his own system, and he should adhere to it if it supplies the information he wishes. In the Station Laboratory Queen Yard a simple device is used to facilitate examination and shows the presence of (a) queen cell, (b) virgin queen, (c) laying queen, and (d) queenless condition. The device should stay where placed and in addition be visible at considerable distance.

**Introducing Queen Cells:** During the tenth day remove the cell frame from the cell-builder. Have a supply of spiral cell protectors at hand in the house. Take one of the cell protectors in the left hand, large end up, and with the right hand remove a good cell by detaching the wooden base from the bar. Place the cell in the protector so that the end of the cell is over the small opening and the wooden base closes the upper opening. Cells should not be handled roughly or exposed to extremes of temperature. A rack for carrying the cells similar to that shown in Figure 3, will be found to be very convenient. One of the protectors with its cell is then placed in each mating colony just at the upper edge of the brood ring and below the honey ring. This is a favorite location for natural cells and has proved to be the best location for those that are introduced.

**Use of Emergency Cells:** In four days the emergency cells should be removed from the cell-building colonies and the virgins from the first lot will have emerged in the mating colonies. Go through the mating colonies and mark those in which the virgin has failed to emerge, has been lost, or is not suitable. In these hives place the emergency cells in protectors and introduce as described above. A few of the cells should be kept in nursery cages and the resultant virgins used to replace other failures in cells or later losses of virgins (see Figure 3).

**Examining for Young Queens:** Ten days after emergence the virgins should be laying. It is well to go through the hives on this day and mark those containing laying queens. If queens are being raised for sale or to put into your own hives they are now ready to be removed. There are several advantages in allowing the queen to stay in the colony twenty-one days from the date the cell was placed in the hive. In these few extra days the queen will lay a sufficient number of eggs to keep up the strength of the mating colony and thus make the one colony raise queens all summer. And by the end of the twenty-one days one can tell whether or not the queen is a drone layer.

**Care of Cell-Building Colonies:** When the emergency cells are taken out of the cell-building portion and the cell frame is removed, place back a cell the same as in introducing a cell into a mating colony.

In this manner the cell-builder will have a laying queen in due time. By this time the queenright portion will have built up to almost normal strength. There will now be two fair colonies of bees, each with a laying queen. If the old queen shows signs of failure she may be discarded and

her colony united with the former cell-building portion, now a queenright colony. If on the other hand the old queen is satisfactory and the young queen is to be used elsewhere, her colony after her removal can be united with the colony containing the old queen. This uniting should be done five weeks after the cell-building colony was prepared. Six weeks after preparing the cell-builder the first time, the colony will be in condition to use again. If the colony is handled in this manner nothing is lost by having a portion of the colony queenless for a time because during the remainder of the time there will be two laying queens to restock the colony. An additional advantage is that an extra queen is produced.

## CAGING AND SHIPPING QUEENS*

**Cage:** Queens sold up to June 15th can be sent safely in short-distance shipping cages but after that date long distance cages should be used. Cages can be bought at about one-half what it cost to make them.

**Queen Candy:** This is a mixture of honey and pulverized sugar used as food for the queen and her escort during shipment. Only experience can give the knowledge of candy making. The following is a recipe for making it, but only the making of many batches will enable one to produce a satisfactory candy: "Select a light colored honey and work a small amount of it into pulverized sugar until a thick dough is produced. This dough should be thick enough not to stick to the fingers and yet not dry enough to crumble. It must be soft enough for the bees to use and not soft

Figure 9—Catch and hold the queen by the wings

enough to smear them." Where one pound, or more, is to be made at a time the job can quickly and easily be done by running the honey and sugar through a common kitchen food-grinder. First pour the honey and sugar at the same time into the hopper of the grinder. This mixture will probably be too thin; so sprinkle with pulverized sugar and run through again, repeating if necessary, until the desired consistency is obtained.

*U. S. Postal Regulations on shipping queen bees: "Queen bees and their attendant bees, when accompanied with a copy of a certificate of the current year from a state or government apiary inspector to the effect that the apiary from which said queen bees are shipped is free from disease or by a copy of a statement by the beekeeper made before a notary public or other officer having a seal that the honey used in making the candy used in the queen mailing cage has been diluted and boiled in a closed vessel."

**Provisioning Cages:** Do not buy cages nailed and provisioned. The candy in such cages is probably dried out. In provisioning cages fill the compartment lined with paraffin. Pack the candy firmly and see that the exit hole is well filled. Remove any surplus with a knife. Lay the wax paper over the candy and tack the screen wire over this. Prepare cages for shipment only a short time before shipping.

**Caging Queens:** Remove the frame with the queen from the mating colony and place it end up against the hive; catch the queen by the wings and gently force her into the cage as shown in Figures 9 and 10. Now catch in like manner ten to fourteen workers for short-distance cages, and double the number for long-distance cages, and place with the queen.

Figure 10—Manner of placing queen in mailing cage

**Mailing:** See that the perforated metal end is fastened on with four 3-8 inch wire nails. The address card plainly and correctly written and having your return address on the end of the card is attached by means of 1-4 inch wire nails. Be sure that a Bill of Health is glued to the bottom side of the cage. Without this certificate the Post Office will not receive queen bees. To obtain such certificate, application for inspection should be made to the State Entomologist, State Apiary Inspector, or corresponding official of the state from which shipment is made. Where several cages go to one address only one address card and bill of health is necessary. Place cages in convenient piles and tie together with frame wire. As queen bees now go by parcel post, see that neither the stamp nor the bill of health is pasted over the wire, as many mail clerks rule that this seals the package and mark it first-class matter. If possible to select the time, start the queens in the evening, as they will then cover most of the trip in the cool of night.

By looking at the calendar suggested on page 15, it will be seen that the next cells are ready to be removed from the cell-builder the day after shipping the queens and the breeder is at the beginning of his second lot of queens.

## TABLE 1

CALENDAR SHOWING DATES OF ALL OPERATIONS IN THE ONE-BROOD SYSTEM USED DURING 1923

| Prepare Cell Builders | Start First Cells | Start Emergency Cells | First Cells Transferred to Mating Colonies | Emergency Cells Transferred to Mating Colonies | Give Caged Virgins where Necessary | Look for Laying Queens; Test last Queens | Take Queens |
|---|---|---|---|---|---|---|---|
| | 3 days | 4 days | 6 days | 4 days | 2 days | 11 days | 3 days |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| Mar. 24 | Mar. 27 | Mar. 31 | Apr. 6 | Apr. 10 | Apr. 12 | Apr. 23 | Apr. 26 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| Apr. 14 | Apr. 17 | Apr. 21 | Apr. 27 | May 1 | May 3 | May 14 | May 17 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| May 5 | May 8 | May 12 | May 18 | May 22 | May 24 | June 4 | Jun. 7 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| May 26 | May 29 | Jun. 2 | Jun. 8 | Jun. 12 | Jun. 14 | Jun. 25 | Jun. 28 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| Jun 16 | Jun. 19 | Jun. 23 | Jun. 29 | July 3 | July 5 | July 16 | July 19 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| July 7 | July 10 | July 14 | July 20 | July 24 | July 26 | Aug. 6 | Aug. 9 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| July 28 | July 31 | Aug. 4 | Aug. 10 | Aug. 14 | Aug. 16 | Aug. 27 | Aug. 30 |
| Sat. | Tues. | Sat. | Fri. | Tues. | Thurs. | Mon. | Thurs. |
| Aug. 18 | Aug. 21 | Aug. 25 | Aug. 31 | Sept. 4 | Sept. 6 | Sept. 17 | Sept. 20 |

**Records:** It is well for every queen breeder to keep a record of his operations and business transactions. A pocket note book properly kept will tell the queen raiser the condition of his mating colonies. A desk book should have full details regarding the orders, remittances, and shipment of all queens. It is a good plan for the queen breeder to adopt a set of rules for replacing queens that are not satisfactory to the customers. One well known rule is to replace only those queens that are returned in unopened cages. As an aid in knowing if the cage is unopened, it should be marked before shipping and the number of escorts should always be the same for the same type of cage. Another rule is not to guarantee the safe delivery of queens when they have to travel a long way on a motor route. While many such shipped queens do get through it is not the fault of the queen breeder when a queen arrives at the destination dead.

## CARE OF STOCK IN MATING COLONY

When for any reason the stock of bees becomes so weakened in numbers that they cannot care for the brood, exchange a comb for one with the adhering bees from a strong colony. It is seldom that any fighting occurs. When the mating colony becomes too strong in bees, remove a frame with the bees and unite this frame by the paper method with a full colony.

Where queens are kept in a mating colony more than 10 days after they have been mated, which may occur in any method of rearing, there is a great possibility that they will abscond shortly after egg-laying begins, especially in summer. To obviate this, put an entrance guard made of queen excluder as soon as the queen is found to be laying. This little operation will save the queen breeder many dollars in the course of a season.

**Wintering Mating Colonies:** The mating colonies winter best as full colonies; so as soon as the last queens are shipped, unite the double mating colonies by the proper method. In a week's time these can be put together either in two eight-frame or two ten-frame bodies. As soon as this operation is over, the beekeeper should see that the united colony has stores for the winter.

## ENEMIES

In Texas the enemies of the queen breeder are spiders, grasshoppers, scorpions, and robber flies. All spiders in and near the mating colony should be killed. Make it a practice to swat every spider, and also kill every scorpion. The grasshoppers that prey on bees are large gray cricket-like insects and should not be allowed to take up their abode around the hive. Among insects, robber flies are probably the greatest catchers of queens. The greatest thief is the red and yellow or red and black robber fly or beehawk (**Deromyia angustipennis** Hine). This monster is very common in Southwest Texas and reports from many queen breeders show that in late summer nearly fifty percent of the virgin queens are killed by robber flies.

TABLE 2

QUEEN PRODUCTION AND ROBBER FLIES AT THE QUEEN YARD OF THE APICULTURAL LABORATORY

| | No. Queens Produced | No Robber Flies Killed |
|---|---|---|
| June 28 | 76 | |
| July 19 | 56 | |
| July 20 | | 358 |
| July 21 | | 105 |
| July 22 | | 20 |
| Aug. 9 | 81 | 483 |

Number of mating Colonies 84

The decline in production of queens during July was undoubtedly largely due to loss of virgins as a result of the depredations of the robber flies. One such instance was observed on July 19 when the mating colonies were examined. On the following three days 483 robber flies were killed and examination August 9 of the next lot of queens showed 81 queens to be present, nearly 50 per cent more than were produced in July.

Observations at the Apicultural Laboratory show that robber flies seldom range over more than two or three acres. If they are numerous and the loss of virgin queens becomes noticeable, two or three hours spent swatting the flies on each of two days will almost end the trouble. Observations made during the remainder of the season showed that the flies did not again increase in number. The ease with which the robber flies can be controlled is surprising. If the killing occurs after July 15 it is not probable that it will have to be repeated. The robber flies are long-lived insects

and the main brood emerges before July 15. These flies are attracted to the yard by the bees and the females lay their eggs in the dirt around the hives. These eggs hatch into wireworm-like larvae that pass the winter a few inches under the surface of the soil of the queen yard, emerging as full grown robber flies the next summer. Thus the menace of robber flies becomes greater year by year, unless something is done. Wet seasons are the queen breeder's friend, as dampness of the soil kills many of the worms. It is probable that where it can be done it would well repay any queen breeder bothered with robber flies to cultivate the surface of his queen yard during the winter.

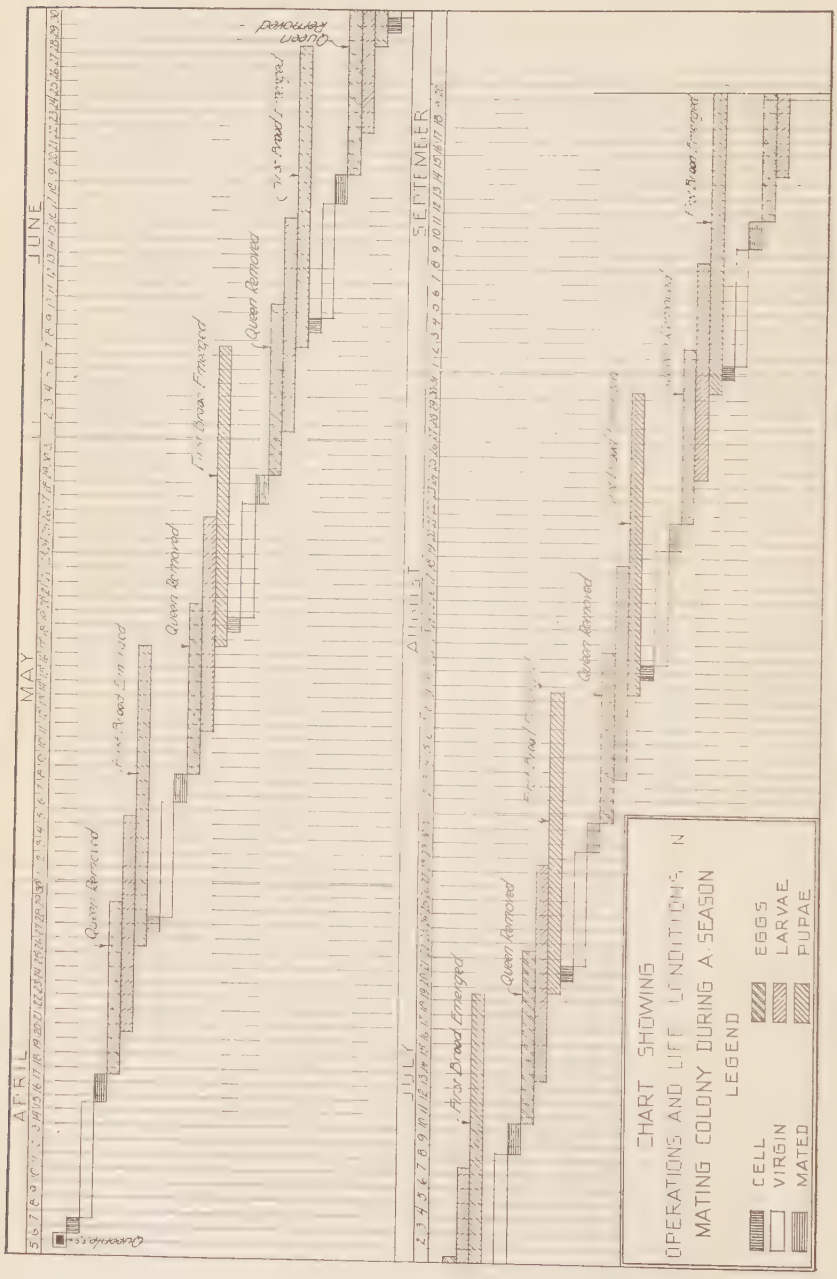
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMER
Queen Removed
First Brood Emerged
CHART SHOWING
OPERATIONS AND LIFE CONDITIONS IN
MATING COLONY DURING A SEASON
LEGEND
CELL
VIRGIN
MATED
EGGS
LARVAE
PUPAE

Figure 11.

## APPLICATIONS OF THE SYSTEM

In the one-brood system a man with 50 colonies of bees with which to run a queen yard may use them as follows: 2 breeding colonies, 10 colonies for cell-builders and reserve, and 38 colonies to stock the mating hives. These should properly stock 115 such mating hives. If this yard is properly managed it should produce 100 queens every 21 days. The calendar, page 15, and the chart, page 18, are for the guidance of those who wish to use this system. A study of the calendar will show that the operations are repeated every 3 weeks. These operations have been fully described. To set the dates for any year, state the date of beginning in the upper left-hand corner. Then by adding the periods which are given you may find the next date. The chart visualizes the operations of the queen breeder for the season. A seeming drawback to the one-brood system is that all the queens must be removed at one time. This, however, is offset by the fact that the beekeeper is not employed every day and such a plan allows him to combine the operations of removing one set of queens and that of testing the purity of mating of the former set.

It can thus be seen that the beekeeper who wishes to have queens for shipping every week can apply the same system by having a similar schedule beginning the same day of each week. This will be found to be a saving in operation, as there will be no need of emergency cells and nursery cages. When 2 or more lots are run a week, it will require 2 men to take care of the work, as this means an output of 100 or more queens per week. Between April 15 and October 15 such an arrangement is economical and will well repay the beekeeper who devotes his entire time to queen rearing.

This system has been tested thoroughly in the State Apicultural Research Laboratory Queen Yard and the following results that were obtained show the advantages of this method of operation: 90 per cent of the cells given were completed by cell-builders; 92 percent of the completed cells produced virgins; and 89 percent of the mating colonies produced laying queens.

## SUPPLEMENTAL LITERATURE SUGGESTED

There have been several publications issued on this subject by the U. S. Department of Agriculture, but none of these is available at the present time.

"Scientific Queen Rearing" by G. M. Doolittle
"Practical Queen Rearing" by Frank C. Pellett
"Queen Rearing Simplified" by Jay Smith
"Modern Queen Rearing" by Mel T. Prichard

10-24-12M

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

W. B. BIZZELL, President

CIRCULAR NO. 36 AUGUST, 1924

DIVISION OF ENTOMOLOGY

# I. FOULBROOD CONTROL AND DISEASES OF BEES
# II. FOULBROOD LAW AND REVISED REGULATIONS

B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

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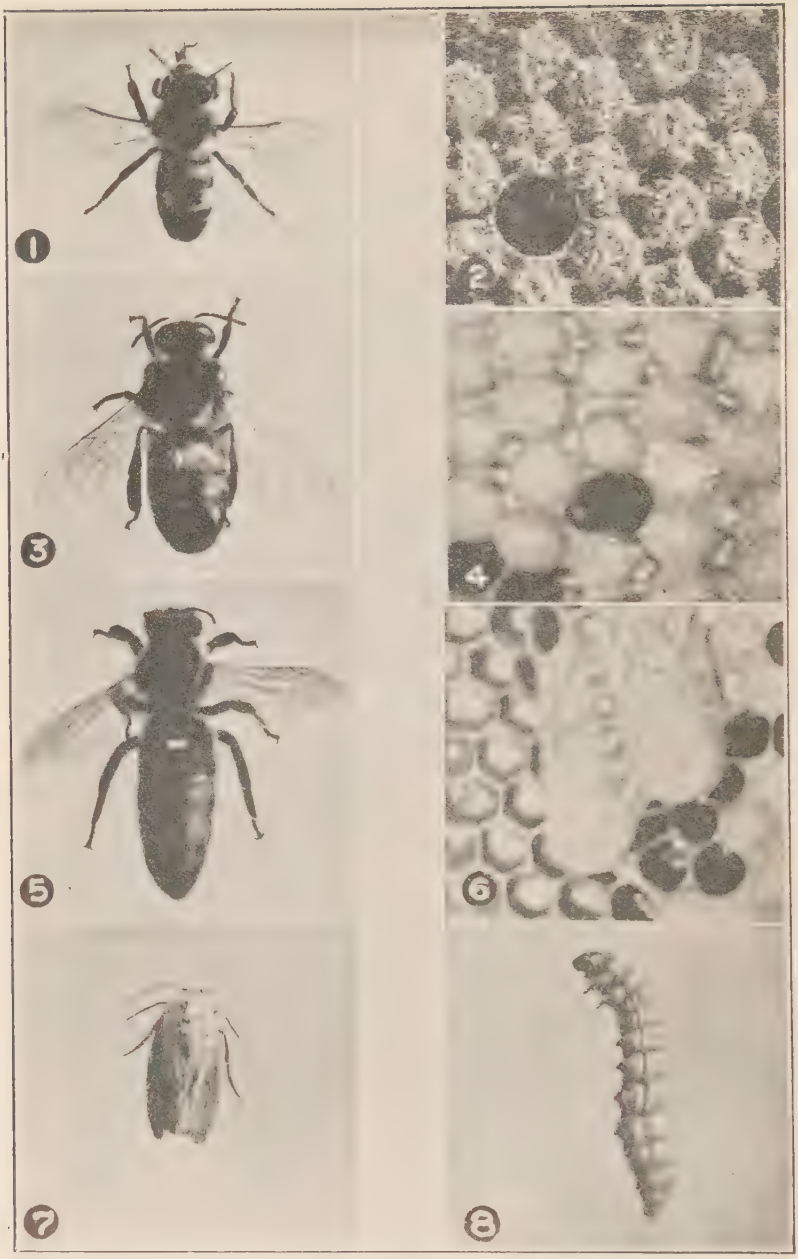
## FOREWORD

This Circular contains a report of the inspection work carried on under the Texas Foulbrood Law during the period 1910 to 1923, inclusive. Descriptions of the more important brood diseases and adult diseases of bees are also given as well as comparisons of the brood diseases in order to facilitate indentification.




The Bee and Wax Moth

The Wax moth is not a disease but is a menace to weak colonies and may be avoided by careful attention.

1. Worker
2. Worker brood
3. Drone
4. Drone brood
5. Queen
6. Queen cells
7. Wax moth
8. Wax moth larva

Circular No. 36 August, 1924

# I. FOULBROOD CONTROL AND DISEASES OF BEES
# II. FOULBROOD LAW AND REVISED REGULATIONS

By

F. L. Thomas, Ph. D., *Chief, Division of Entomology; State Entomologist,

and

C. S. Rude, B. S.

## INTRODUCTION

In 1901 the Texas Beekeepers Association, realizing the dangerous nature of foulbrood diseases of bees, attempted to secure the passage of a law by the State Legislature which would provide for their control or eradication in the State. It was not until in 1903, however, that the efforts of the Association met with success, and such a law was enacted.

At the time of its passage no appropriation was made for carrying out the provisions of the act. Two years later the Twenty-ninth Legislature appropriated $1600 for the years 1906 and 1907. This fund was used by the State Entomologist's office for inspecting and treating apiaries for American foulbrood. The inspection work showed the disease to be widespread through the beekeeping section of the State.

At this critical time the work was brought to an abrupt stop by the failure of the Thirtieth Legislature to make any appropriation for the biennium ending August 31, 1909. The Thirty-first Legislature appropriated $3000 for the foulbrood eradication work for the two years ending August 31, 1911.

Wilmon Newell, State Entomologist at that time, established the system of using county inspectors and his work marks the beginning of a systematic campaign for the control of foulbrood in the State.

The Thirty-third Legislature passed the present foulbrood law, but failed to provide funds for its enforcement. However, on March 22, 1915, an emergency appropriation of $3000 was signed by the Governor and the work was resumed in April of that year.

The system of having county inspectors was used until in the spring of 1920, when three inspectors for the State at large were employed and worked out from College Station as headquarters. The plan worked so well that it was decided in 1921 to have the major part of the work done by State rather than county inspectors, using the latter only in those parts of the State where it seemed very desirable to have a local man easily available for emergency work. The work of the local man was not restricted by county limits and he could be called upon for work anywhere in his section of the State. The name was changed from county inspector to local inspector. The combination of State and local inspectors has proved an ideal one for Texas conditions.

*This manuscript was partially completed by Dr. M. C. Tanquary, who was succeeded by Doctor Thomas, May 1, 1924.

## REPORT OF INSPECTION WORK

Prior to the year ending August 31, 1911, the work in foulbrood control was more or less preliminary and for that reason the results cannot be tabulated. However, this work was valuable in that it located the major diseased areas and formed a basis for further work. The following tables show the work that has been done since the year ending August 31, 1910. In these tables the year is considered as beginning September 1 and ending August 31.

Table 1

Summary by years of all inspection work September 1, 1910, to August 31, 1923

| Date | Number of Colonies | | | | | Number of Counties Worked |
|---|---|---|---|---|---|---|
| | Examined | American Foulbrood | | | | |
| | | Found | Treated | Destroyed | Unaccounted For | |
| 1910-1911 ..... | 19863 | 270 | 178 | 75 | 17 | 9 |
| 1911-1912 ..... | 31819 | 283 | 230 | 53 | 0 | 11 |
| 1912-1913 ..... | 19775 | 323 | 211 | 85 | 27 | 17 |
| 1913-1914 ..... | 0 | 0 | 0 | 0 | 0 | 0 |
| 1914-1915 ..... | 12017 | 341 | 154 | 66 | 121 | 18 |
| 1915-1916 ..... | 45621 | 574 | 238 | 165 | 171 | 25 |
| 1916-1917 ..... | 22665 | 224 | 126 | 54 | 44 | 22 |
| 1917-1918 ..... | 38648 | 398 | 147 | 177 | 74 | 21 |
| 1918-1919 ..... | 35615 | 401 | 191 | 110 | 100 | 44 |
| 1919-1920 ..... | 25676 | 687 | 156 | 515 | 16 | 35 |
| 1920-1921 ..... | 39741 | 499 | 60 | 439 | 0 | 55 |
| 1921-1922 ..... | 45530 | 618 | 77 | 541 | 0 | 65 |
| 1922-1923 ..... | 42960 | 334 | 13 | 321 | 0 | 60 |

It will be noticed that no work was done during the year 1913-14. This was due to the failure of the legislature to provide funds for conducting the work.

The distribution of American foulbrood in Texas is shown by the map in Figure 1. The areas in black indicate those counties where American foulbrood was found in 1923. The shaded areas show the counties in which American foulbrood has been found but which were free of disease in 1923.

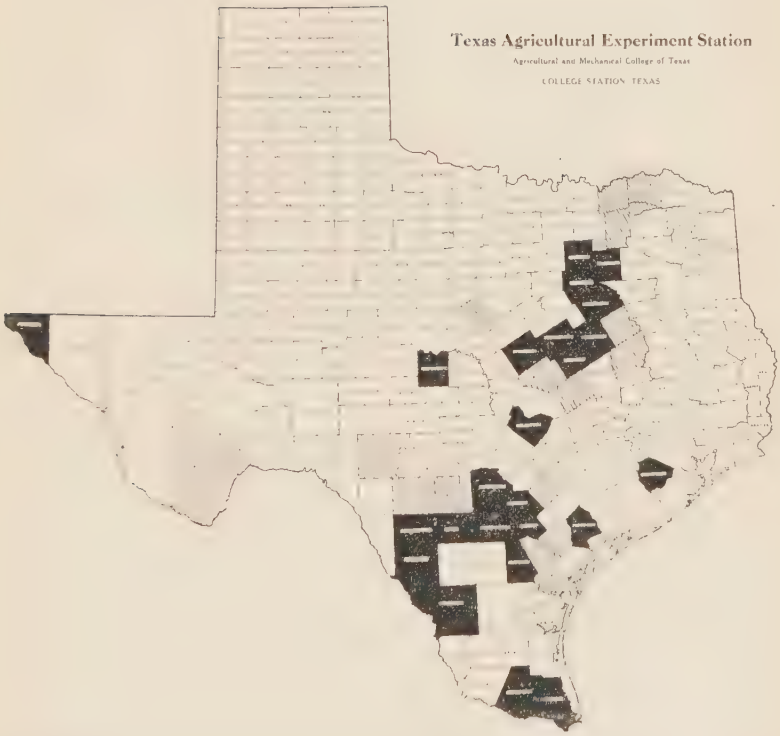



Figure 1. Distribution of American foulbrood in Texas. Counties in black are those in which the disease was found in 1923. Shaded areas show where the disease has been eliminated.

TABLE 2

The total number of colonies inspected each year in the counties where American foulbrood has occurred.

| County | 1910-'11 | 1911-'12 | 1912-'13 | 1913-'14 | 1914-'15 | 1915-'16 | 1916-'17 | 1917-'18 | 1918-'19 | 1919-'20 | 1920-'21 | 1921-'22 | 1922-'23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atascosa | .... | 3268 | 344 | .... | 55 | 3619 | 1471 | 50 | 888 | 1213 | 4521 | 3181 | 2992 |
| Bee | 474 | 1367 | 1292 | .... | .... | 522 | 3194 | 868 | 1509 | 922 | 2370 | 872 | 451 |
| Bell | .... | .... | .... | .... | 95 | 3086 | 1091 | 2009 | 368 | 111 | .... | .... | 390 |
| Bexar | 579 | 2440 | 1968 | .... | 537 | 2418 | .... | 2034 | 3448 | 2817 | 3809 | 3551 | 2022 |
| Brewster | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 253 | .... |
| Cameron | .... | .... | .... | .... | .... | .... | .... | 1106 | 537 | 266 | 1078 | 792 | 1047 |
| Comanche | .... | .... | .... | .... | .... | .... | .... | .... | .... | 5 | 40 | 61 | 91 |
| Coryell | .... | .... | .... | .... | .... | .... | .... | .... | .... | 169 | 109 | .... | 279 |
| Dallas | .... | .... | .... | .... | .... | .... | .... | .... | 70 | 1375 | 1012 | 948 | 715 |
| Delta | .... | .... | .... | .... | 260 | 1547 | 90 | .... | .... | .... | 141 | 211 | .... |
| Dimmit | .... | .... | .... | .... | .... | .... | .... | .... | 2465 | 2037 | 982 | 567 | 1504 |
| Edwards | .... | .... | .... | .... | .... | .... | .... | 228 | 1539 | 141 | 272 | .... | .... |
| Ellis | .... | .... | .... | .... | 1936 | 1272 | 1573 | 2005 | 2086 | 1756 | 2424 | 2557 | 4412 |
| El Paso | .... | .... | .... | .... | .... | .... | .... | 171 | 327 | 105 | .... | 630 | 1163 |
| Falls | .... | .... | .... | .... | .... | 1300 | 737 | 1780 | 1382 | 1490 | 614 | 634 | 1179 |
| Fannin | .... | .... | .... | .... | .... | 1953 | .... | 2011 | 430 | .... | .... | 578 | .... |
| Fort Bend | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 145 | 541 |
| Freestone | .... | .... | 11 | .... | .... | 105 | .... | 115 | 125 | 16 | 75 | 112 | .... |
| Frio | .... | 6475 | 1234 | .... | 1335 | 1917 | 627 | 538 | 2035 | .... | 488 | 4106 | 2259 |
| Goliad | .... | .... | 425 | .... | 141 | 96 | .... | 72 | 140 | .... | 300 | 46 | .... |
| Gonzales | .... | .... | .... | .... | .... | .... | .... | 112 | 98 | .... | .... | .... | .... |
| Hidalgo | .... | .... | .... | .... | .... | .... | .... | 271 | .... | .... | 1563 | 891 | 1194 |
| Hunt | .... | .... | 11 | .... | 947 | .... | .... | 1117 | 846 | 1100 | 41 | 950 | 739 |
| Karnes | .... | .... | .... | .... | 193 | 54 | .... | 1038 | 484 | 311 | .... | 1188 | 872 |
| Kaufman | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 103 | 129 | 175 |
| Lamar | .... | .... | .... | .... | 401 | 2069 | 455 | 457 | 766 | 574 | 445 | 1183 | 627 |
| Leon | .... | .... | 597 | .... | .... | 2388 | 1759 | 2161 | 423 | .... | 35 | 541 | 141 |
| Limestone | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 266 | .... | 443 |
| Live Oak | 3209 | 892 | 1362 | .... | .... | .... | 2673 | 1261 | 1931 | 963 | 4163 | 1530 | 1380 |
| McCulloch | .... | .... | .... | .... | 232 | 1575 | 812 | .... | .... | 181 | 486 | 121 | 608 |
| McLennan | .... | .... | .... | .... | 100 | 948 | 1609 | 2540 | 1817 | .... | 1 | 326 | 732 |
| Milam | .... | .... | .... | .... | .... | 2051 | 733 | 717 | 730 | 566 | 147 | .... | 874 |
| Medina | .... | .... | .... | .... | .... | 1699 | 275 | .... | 146 | .... | 220 | 186 | 48 |
| Navarro | .... | .... | .... | .... | .... | .... | .... | 70 | 125 | 622 | 217 | 97 | 2214 |
| San Patricio | 2941 | 1549 | 2456 | .... | .... | 1885 | 1431 | 390 | 696 | .... | 1051 | 1308 | 675 |
| Travis | .... | .... | .... | .... | .... | .... | .... | .... | 50 | 455 | 199 | 1746 | 930 |
| Uvalde | 7732 | 2319 | 2659 | .... | 625 | 1126 | 755 | 3882 | 1307 | 2583 | 2279 | 3166 | 2425 |
| Victoria | .... | .... | 765 | .... | 585 | 585 | 196 | 365 | 170 | 208 | 301 | 32 | 272 |
| Webb | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 502 | 234 | 332 |
| Wilson | .... | 6017 | 2898 | .... | 3507 | 6723 | 735 | 708 | 210 | .... | 178 | 1740 | 641 |
| Zavalla | 4777 | 6274 | 3312 | .... | 897 | 4681 | 1899 | 5196 | 4696 | 2085 | 1340 | 1067 | 1114 |

TABLE 3

The number of colonies infected with American foulbrood found as a result of inspection work 1910-1923.

| County | 1910-'11 | 1911-'12 | 1912-'13 | 1913-'14 | 1914-'15 | 1915-'16 | 1916-'17 | 1917-'18 | 1918-'19 | 1919-'20 | 1920-'21 | 1921-'22 | 1922-'23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atascosa | | 12 | 8 | | 10 | 14 | 31 | | | 22 | 71 | 48 | 42 |
| Bee | | | | | | | | | | | *53 | | |
| Bell | | | | | 8 | 22 | 21 | 21 | 2 | | | | |
| Bexar | 25 | 185 | 59 | | 9 | 200 | | 78 | 112 | 200 | 75 | 94 | 37 |
| Brewster | | | | | | | | | | | | 41 | |
| Cameron | | | | | | | | 1 | | | | | 3 |
| Comanche | | | | | | | | | | 2 | | 3 | |
| Coryell | | | | | | | | | | 63 | | | 5 |
| Dallas | | | | | | | | | | 36 | 22 | 17 | 5 |
| Delta | | | | | 65 | 21 | 3 | | | | | | |
| Dimmit | | | | | | | | | 20 | 112 | 1 | 16 | 2 |
| Edwards | | | | | | | | | 3 | | | | |
| Ellis | | | | | 47 | 27 | 85 | 79 | 116 | 24 | 17 | 4 | 33 |
| El Paso | | | | | | | | 2 | 4 | | | 7 | 27 |
| Falls | | | | | | 10 | 2 | 83 | 81 | 38 | 19 | 16 | 4 |
| Fannin | | | | | | 73 | | 41 | 3 | | | 25 | |
| Fort Bend | | | | | | | | | | | | 67 | 31 |
| Freestone | | | | | | | | | | | | 1 | |
| Frio | | | 11 | | | 6 | 2 | | 5 | | | 1 | 6 |
| Goliad | | | | | | | | | | | | 2 | |
| Gonzales | | | | | | | | | 3 | | | | |
| Hidalgo | | | | | | | | | | | 98 | 9 | 15 |
| Hunt | | | 6 | | | | | 30 | 15 | 19 | 3 | 11 | |
| Karnes | | | | | 2 | | | 1 | 1 | | | 6 | 1 |
| Kaufman | | | | | | | | | | | 11 | 3 | 6 |
| Lamar | | | | | | 9 | | | 1 | 4 | | | |
| Leon | | | | | | | | | | | | 5 | |
| Limestone | | | | | | | | | | 1 | | | 3 |
| Live Oak | 2 | | | | | | | | | 18 | 13 | 2 | 3 |
| McCulloch | | | | | | | | | | | | | 33 |
| McLennan | | | | | 38 | 31 | 39 | 7 | 12 | 3 | | | 5 |
| Milam | | | | | | 14 | 19 | 1 | | | | | |
| Medina | | | | | | 3 | | | 16 | | | | |
| Navarro | | | | | | | | | | 19 | 14 | 1 | 15 |
| San Patricio | 85 | 9 | 16 | | | 5 | | | | | | 10 | |
| Travis | | | | | | | | | | 2 | 3 | 19 | 20 |
| Uvalde | 58 | 3 | 25 | | 4 | 2 | | | | 9 | 12 | 1 | |
| Victoria | | | 100 | | 50 | 71 | 20 | 3 | | 6 | 5 | | 1 |
| Webb | | | | | | | | | | | 70 | 19 | 23 |
| Wilson | | 51 | 96 | | 108 | 63 | 1 | 51 | 7 | | 2 | 60 | 2 |
| Zavalla | 100 | 23 | 2 | | | 3 | 1 | | | 2 | 1 | 45 | 13 |

*These bees were in Live Oak County; error in locating them.

### Inspection of Queen Breeding Apiaries

In addition to the clean-up work each year there have been numerous inspections of apiaries for queen breeders and shippers of package bees. This work is valuable in that it reduces the possibility of the spread of disease by shipping bees and queens from infected apiaries.

### Method of Making Inspections

All brood frames of each colony in an apiary are inspected. A plan of area clean-up is now in use. As soon as a case of foulbrood is located a careful inspection of the area is made. All colonies are examined, the inspectors working in ever increasing distance from the location of the

diseased yard as a center, until no disease is found. The policy of burning diseased colonies is generally followed as it has proved to be the safest and cheapest method of combating American foulbrood.

Figure 2 shows the percentage of colonies infected by American foulbrood during the period from 1910 to 1923. It will be noticed that in 1913-14 there is no record. This is due to the fact that there was no appropriation made for the work of foulbrood eradication. It will also be noticed that following this year when no eradication work was done the percentage of American foulbrood found reached its highest point. Another high point was reached in 1919-1920. For a year or two previous to that time little or no work had been done in some of the counties where foulbrood existed. It had in that way gained considerable headway in those counties. In spite of these two high points there has been a constant reduction of foulbrood as is shown by the straight line RR. This line not only indicates a reduction but also gives the rate of reduction over the period from 1910 to 1923.

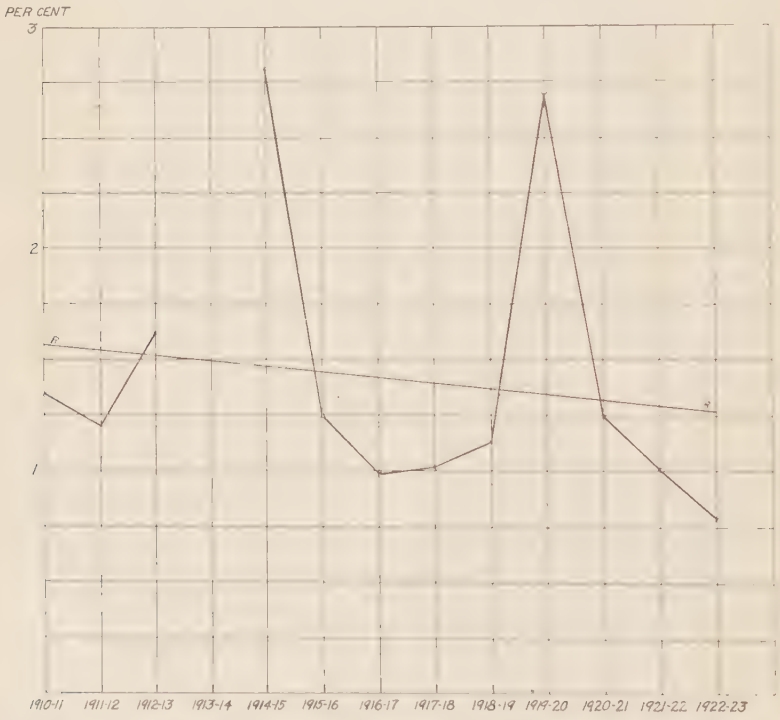



Figure 2. Percentage of colonies (indicated on the left) infected with American foulbrood during the period 1910-1923.

## BEE DISEASES

Diseases of bees fall naturally into two groups, those affecting the brood, or "brood diseases", and those affecting the adult bee, or "adult diseases". The beekeeper sustains his heaviest losses from the brood diseases, although at times comparatively large losses occur as the result of adult diseases.

### Brood Diseases

There are three well-known brood diseases of bees. In order of their importance they are American foulbrood, European foulbrood, and sacbrood. American foulbrood and sacbrood both occur in Texas, but up to the present time no authentic case of European foulbrood has ever been reported.

**American Foulbrood:** American foulbrood is by far the most serious brood disease found in Texas and the most difficult to combat. It is a bacterial disease, the causative organism being known as Bacillus larvae, which, while certain death to developing bees, is not harmful to man's health.

In American foulbrood the symptoms vary within certain limits. The colony may or may not be noticeably weakened, depending upon the age of the case. The colony gradually weakens until death is finally brought about. The brood in an infected colony is scattered and often the cappings are discolored, sunken, and punctured. The adult bees often cut the capping off of the cell after the larva dies. This leaves a large number of open cells, which gives a scattered appearance to the brood. However, at times the cappings covering dead brood may appear very much like those covering healthy brood. One or more of these symptoms may be absent but more often all are combined.

American foulbrood usually shows in the larva about the time that the larva fills the cell and after it has ceased feeding and has begun pupation. At this time it is sealed over in the comb. The first indication of the infection is a slight brownish discoloration and the loss of the well rounded appearance of the normal larva. At this stage the disease is not usually recognized by the beekeeper. The larva gradually sinks down in the cell and becomes darker in color; the posterior end lies against the bottom of the cell. Frequently the segmentation of the larva is clearly marked.

By the time it has partially dried down and assumed a decided brown color the most typical characteristic of this disease manifests itself. If a match stick or toothpick is inserted into the decaying mass and withdrawn the larval remains adhere to it and are drawn out in a thread. This thread is of a silky smoothness in texture and often may be drawn out for two or three inches before it breaks. This is known as ropiness and is the chief characteristic made use of by the beekeeper in diagnosing this disease. The larva continues to dry down and gradually loses its ropiness until it finally becomes merely a scale adhering tightly to the lower side wall of the cell and cannot be easily removed. The scales can best be

observed when the comb is held with the top inclined toward the observer so that a bright light strikes the lower side wall of the cell. A very characteristic and usually penetrating odor is often noticable. This has been likened to the odor of heated glue.

The majority of the larvae which die of this disease are sealed in the cells prior to death. The bees often entirely remove the cappings, but when they are left, they usually become sunken and frequently perforated. As the healthy brood emerges the comb shows the scattered sunken cappings covering dead larvae, giving it a characteristic appearance. Young unsealed larvae are sometimes affected.

Pupae also may die of this disease, in which case they, too, dry down, become ropy, and have the characteristic odor and color. The tongue frequently adheres to the upper side wall and often remains there even after the pupa has dried down to a scale. In all stages the decaying mass adheres very tightly to the cell wall.

Usually the disease attacks only worker brood, but occasionally cases are found in which queen-brood and drone-brood are diseased. There is nothing to indicate that the race of bees, season, or climate has any effect on the virulence of the disease, except that in warmer climates, where the breeding season is prolonged, the rapidity of devastation is more marked

It is possible under very favorable conditions to treat American foulbrood by transferring the bees without any honey to clean fixtures in which they are forced to build new combs before they can rear brood. If ever so small an amount of honey is carried over from the old hive or exposed to the bees the treatment will be a failure and the chances are that the disease will be spread rather than checked. For this reason treating for American foulbrood is not here advised. Where only a light infestation of the disease appears it is a great deal cheaper, and by far safer, to burn the entire colony, or colonies. The time to clean up foulbrood in an apiary is when it is just starting, not after many of the colonies are diseased.

Recently rather promising results have been obtained by treating diseased combs with certain chemicals, but these have not yet been given exhaustive enough tests to be recommended here. The great danger in treating colonies affected with American foulbrood is the general lack of appreciation of the fact that absolute thoroughness is necessary in order to get results, and that even a tiny drop of diseased material which has been overlooked may undo all the work of treating that has been done.

**Sacbrood:** Sacbrood is caused by a filterable virus, the specific causative organism not yet having been isolated. The greatest danger from this disease is the chance of confusing it with American foulbrood. At first glance these two diseases appear very similar but upon close examination they are easily distinguishable.

The larvae are affected at about the same age in this as in American foulbrood. The first noticeable symptom is the loss of the well rounded shape and a dulling of color. The larva lies on the lower side wall of the cell with the outer end turned upward, thus assuming what is commonly called a gondola shape. The color varies from a light yellow to a dark

brown. There is no ropiness. The cuticle or body wall of the dead larva is quite tough and the larva can be removed from the cell intact. Upon breaking through the cuticule one finds the larva to contain a watery granular fluid, having the same appearance as sugar partially dissolved in water.

This disease is usually not the cause of any serious loss in the apiary, and in general no treatment is necessary. It is wide-spread and appears and disappears erratically.

**European Foulbrood:** European foulbrood, like American foulbrood, is a bacterial disease and is caused by Bacillus pluton. It usually attacks the larva at an early stage of its development while it is still curled up at the base of the cell. A small percentage of larvae die after capping, in which case sunken and perforated cappings are observed just as in American foulbrood.

The earliest indication of the disease is a slight yellow or gray discoloration and uneasy movements of the larva and a loss of its plump and opaque appearance. It becomes slightly translucent and the tracheae may become very prominent giving a clearly segmented appearance. The larva is usually flattened against the base of the cell but may turn so that the ends of the larva are to the rear of the cell, or may fall away from the base. Later the color changes to a decided yellow and the translucency is lost. The lemon yellow color may be taken as the chief characteristic of the disease. The dead larva appears as a moist, somewhat collapsed mass, giving the appearance of being melted.

When the remains become almost dry the tracheae sometimes become conspicuous again, this time by retaining their shape, while the rest of the body contents dries around them. Finally all that is left of the larva is a greyish-brown scale against the base of the cell or on the lower side wall if the larve did not retain its normal position. The scales do not adhere to the cells and can easily be removed.

Decaying larvae which have died of this disease are not usually ropy and when ropiness does occur it is slight and not similar to that occurring in American foulbrood, lacking the elasticity and smothness in texture. Drone-brood and queen-brood are atacked almost as readily as worker brood.

European foulbrood is more destructive during the spring and early summer than at other times, often entirely disappearing during late summer and autumn.

The most satisfactory method of combating this disease is to keep the colony strong and headed by a strong and vigorous queen. The disease may be treated quite successfully by a system of dequeening and requeening, allowing several days' time between the operations.

HELPS FOR IDENTIFYING DISEASES

| | American Foulbrood | European Foulbrood | Sac Brood |
|---|---|---|---|
| Cause | Bacillus larvae | Bacillus pluton | Filterable virus |
| Cappings | Often sunken, discolored and perforated | Usually not sealed | Sunken and perforated |
| Age of larvae | Usually die after capping | Usually die before capping | Die after capping |
| Color | Dark brown | Lemon yellow to grey | Dark brown |
| Consistency | Glue-like, ropy | Soft, moist, often slimy | Watery and granular |
| Cuticle | Disintegrates. Brood sticks to cell | Tough. Brood does not stick to cell | Intact, tough, brood does not stick to cell |
| Position in cell | Lengthwise on lower side wall. Soon becomes shapeless | Usually curled at bottom of cell | Lengthwise on lower side wall. Gondola-shaped |
| Scales | Dark brown. Adhere tightly to cell | Yellow to brown. Free at bottom of cell | Dark brown. Free |
| Brood affected | Usually worker; may affect queen and drone brood | Worker, drone and queen | Worker |

## How American Foulbrood Is Spread

American foulbrood may be spread in a number of ways, many of which may be summed up as careless beekeeping. Some of the most common ways of spreading it are as follows: Feeding honey from diseased colonies; allowing bees to rob diseased colonies; use of infected materials such as combs, hives and the like; working healthy colonies with the same tools that have been used in a diseased colony without properly disinfecting them.

The following history of actual outbreaks will show very plainly how easily foulbrood may be spread.

In 1915 Mr. "A" purchased from Mr. "B", who lives 21 miles northwest of him, some second-hand hives. Mr. "B" had lost a large number of colonies of bees from American foulbrood but did not tell Mr. "A" about it. Mr. "A's" apiary had always been free from American foulbrood, but shortly after putting these second-hand hives into use several cases developed. They were treated by shaking, but in a few weeks several more cases broke out. Mr. "A" began to get discouraged and neglected his apiary. A short time later he moved away and left his bees where they

were. During the winter a hunter found the apiary and noting its run-down condition took it for granted that no one cared much about it, and helped himself to a super of honey, which he took home. He squeezed out the honey and threw the remains of the combs outdoors. The hunter lived 10 miles east of the apiary of Mr. "A" and just across the irrigation canal from Mr. "C", who had a fine clean apiary of ninety colonies. Some days later he told Mr. "C" about the supper of honey, in a joking way, and that he was feeding the bees the part that he did not want.

Mr. "C", who at that time was not acquainted with American foulbrood and did not know of the condition of Mr. "A's" apiary, thought nothing of the incident until the following fall when the state inspectors found all but nineteen of his fine colonies infected with foulbrood. Mr. "C" was willing to cooperate in every way with the inspectors in checking the disease. While the disease is not yet entirely stamped out of his apiary it is under control. The apiary of Mr. "B" was entirely destroyed by the disease, while that of Mr. "A" has been cleaned up and the disease eradicated.

Another interesting case is that of Mr. "X", who purchased several second-hand cans from a company that buys and packs large quantities of honey. In each of these cans there was a little honey that had not been drained out when the cans were emptied. Mr. "X", not thinking of any disease, allowed his bees to clean out these cans. The following fall he began to notice colonies that were not doing just as they should. The brood was scattered and some few colonies died.

Mr. "X" did not recognize the condition as American foulbrood and allowed it to run on for another year. In the meantime he had lost all but a few colonies. Thinking to realize a part on the bees he began selling hives to his neighbors, never once thinking of foulbrood. The next summer one of his neighbors called for an inspection. Upon inspection it was found without exception that where one of those hives had gone foulbrood had developed. A careful inspection was made and in the course of two years the disease was well under control if not eradicated.

The two instances selected from many which might be given go to show that the beekeeper cannot be too careful in the use of second-hand equipment, feeding, and the like. It also shows how easily the beekeeper many become careless and overlook foulbrood. Whenever there is any doubt about the health of brood, the beekeeper should get in touch with the state inspector and have the question settled at once rather than wait until the whole apiary is infected. A great many of the heavy losses from foulbrood are due to neglect or carelessness of the beekeeper in not watching the brood nest for dead brood and ascertaining the cause of death.

### Adult Bee Diseases

The diseases of the adult bees are but imperfectly known and there is a great need for further investigation along this line. In view of this condition it is impossible to give much help in treatment. Of the adult bee diseases the most important are: dysentery, paralysis, spring dwindling, nosema, and Isle-of-Wight disease.

**Dysentery:** Bees do not normally eject their feces in the hive, but if confined there for a time, feces may so accumulate that the bees are forced to eject them. The bees under these conditions become abnormally active and rush about in the hive, thus raising the temperature, and the combs and walls of the hive are spotted with fecal material. If the bees are allowed to take a flight, the difficulty usually will soon disappear, but if this cleansing flight is denied them, either by weather condition or other agencies, the colony will soon dwindle and die.

Dysentery is caused by the accumulation of indigestible parts of food in the alimentary canal. Some honeys contain more of these indigestible materials than others. Honeydew honey, for example, contains a large amount of such material while sugar syrup and the better grades of honey contain very little. If the proper kind of stores are provided there will be little or no difficulty from dysentery.

**Paralysis:** Paralysis is a term that is applied to a group of disorders: The bees tremble or quiver, have a greasy appearance, and ultimately die. There seems to be a great many conditions under which the malady occurs. There is really very little known about the cause and any attempt to give advice would be unwise. It is likely that there are several agencies which produce similar conditions, all of which are known by the same name. It is therefore useless to attempt to give any one cure for "paralysis".

**Spring Dwindling:** Spring dwindling is not a disease in the true sense of the term. Nevertheless, serious losses often occur from this cause. Spring dwindling is brought about by a combination of adverse conditions which separately would not be serious, but when combined are disastrous.

Briefly, the situation is as follows: The bees go into winter with too few young bees and with inferior stores. When spring comes the old bees do not have the required vitality to gather honey and build up the colony strength. It is also common to find cool weather or quick cold showers prevalent during a spring when this disorder reaches its worst.

The old bees that do not have a reserve of vitality go to the field and load up on nectar or pollen and are chilled. They are rendered unable to fly and die in the field. This soon destroys the field force and the duties within the hive are neglected or imperfectly performed, owing largely to the lack of individuals to perform them. The result is that the brood is underfed and irregular, the colony strength is reduced, and the colony builds up slowly, if at all. Usually this condition results only in a very serious weakening of colonies, but frequently there is a quite heavy loss of colonies as well, and it is not uncommon for entire apiaries to die.

Once the condition is in the apiary it become a quite serious problem. It is possible to secure some relief by feeding good stores and by adding young bees. However, it cannot be hoped to offset the damage entirely in this way. The better plan is to have the colonies well stocked with young bees and provisioned with good stores in the fall. A colony in this condition in the fall has a very good chance of coming through a bad spring.

It is possible for a colony to go into winter with an abundance of young bees but to age rapidly on account of excessive activity and in the spring

be no better than much older bees. The beekeeper should indeavor to prevent as far as possible excessive activity by removing the cause and by putting the bees into winter in good shape.

**Nosema Disease:** Nosema disease is an infectious disease of adult bees caused by an animal parasite (Nosema apis). Colonies affected by this disease exhibit symptoms similar to the so-called paralysis. Bees are often noticed crawling out of and away from the hive. They have lost the power of flight, their abdomens are distended, and have a slick shiny appearance. The stomach presents a milky appearance when crushed and upon microscopic examination Nosema apis is found in large numbers in the crushed tissues. The losses from this cause are not usually large. No very satisfactory remedy has ever been worked out.

**Isle-of-Wight Diesase:** In the early part of this century a serious epidemic swept over England. This disease was first noticed and examined on the Isle of Wight and it has come to be known as the "Isle-of-Wight" disease. The symptoms as described by P. B. White are as follows:

"The disease is characterized both by the symptoms of the individual bee and by the disorganization of the communal life of the hive.

"The onset of the disease in a stock (colony) may be marked by various premonitory symptoms. The foraging bees, leaving and returning to the hive, may show a certain listlessness, lingering before the hive. Presently the first crawlers appear, bees which, incapable of flight, crawl aimlessly on the ground. As the disease progresses the number of crawlers increases, and on warm days hundreds of stricken bees may be seen before the hive. The diesase may run a varying course; it may progress steadily until the depleted and disorganized stock perishes or may wax and wane, often showing signs of periodicity. In badly affected stocks the routine of the hive is upset, foraging is half-hearted, the hives become soiled with feces, and no longer withstand robbers, which enter with impunity. It is seldom, if ever, that a diseased stock survives the winter."

In 1920 the cause was found to be a very small mite (Acorapis woodi) which enters the air tubes or tracheae in large numbers and produces the disorder.

The disease has never been reported in the United States, but measures have been taken to prevent its introduction.

## SUMMARY

The number of colonies examined by the foulbrood inspectors has increased from less than 20,000 in 1910-1911 to about 43,000 in 1922-1923.

The number of counties in which work has been done has increased from 9 to 60 during the same period.

The general trend of the results shows that the percentage of colonies infected with American foulbrood is gradually decreasing. In 1922-1923 the lowest point was reached, less than one per cent of the colonies being found infected with American foulbrood.

This disease was found in 24 counties in 1922-1923, Karnes and Victoria counties having one case each, while 42 cases were found in Atascosa county.

Burning the diseased colonies has proved to be the safest and cheapest method of combating American foulbrood.

Only two of the well-known brood diseases of bees, American foulbrood and sacbrood, were found in Texas during the period covered by this report.

American foulbrood is spread mainly by feeding honey from diseased colonies and by careless methods of beekeeping. Second-hand equipment should not be used unless properly sterilized.

The adult bee diseases of which dysentery, paralysis, spring dwindling and nosema disease are examples, are less troublesome and not as well understood.

## THE TEXAS FOUL BROOD LAW
### Revised Regulations

The present foul brood law of Texas was enacted by the Thirty-third Legislature, approved March 27, 1914, and became a law ninety days later. It embodied many advantages over the previous law.

The Chief, Division of Entomology, Texas Agricultural Experiment Station, is named in the law as the State Entomologist who is charged with the enforcement of the law.

GENERAL LAWS OF TEXAS, THIRTY-THIRD LEGISLATURE

H. B. No. 11.) Chapter 51

An Act to amend Chapter CXXVI of the Acts of the Regular Session of the Twenty-eighth Legislature, entitled "An Act to provide for the protection of honey bees against foul brood and other contagious diseases, and providing that all beekeepers report to the State Entomologist when infectious diseases exist; providing for collecting the expense of eradicating the disease, and fixing the charges upon the owner or agent of the bees; providing for the extermination of all contagious diseases; and providing penalties for the violation of any of the provisions of this Act," and declaring an emergency.

**Be it enacted by the Legislature of the State of Texas:**

Section 1. That Chapter CXXVI of the Acts of the regular session of the Twenty-eight Legislature be, and the same is, hereby amended so as to hereafter read as follows:

Section 2. That for the purpose of carrying out the provisions of this Act, the Entomologist of the Agricultural Erperiment Station of the Agricultural and Mechanical College of Texas shall be the State Entomologist of this State, and as such it shall be his duty to enforce the provisions of this Act and to issue such rules, regulations, etc., as are hereinafter required. As State Entomologist he shall receive no fees or remuneration other than his regular salary as Entomologist of the Experiment Station and State Entomologist; provided, that he may be reimbursed for necessary expenses incurred in discharge of his duties as State Entomologist. He shall employ such assistants and inspectors as may be necessary, subject to the approval and confirmation of the Director and Governing Board of the Texas Agricultural Experiment Station. He

shall make an annual report to the Director and Governing Board of the Experiment Station, such report giving a detailed account of all funds received and disbursed, and for what purpose, as well as a full report upon all prosecutions, etc., made under the provisions of this Act.

Section 3. The said State Entomologist shall have full and plenary power to deal with all contagious or infectious diseases of honey bees which, in his opinion, may be prevented, controlled or eradicated; and shall have full power and authority to make, promulgate and enforce such rules, ordinances, orders and regulations, and to do and perform such acts as, in his judgment, may be necessary to control, eradicate or prevent the introduction, spread or dissemination of any and all contagious diseases of honey bees as far as may be possible, and all the rules, ordinances, orders and regulations of said State Entomologist shall have the force and effect of the law in so far as they conform to the general laws of this State and the United States. The State Entomologist, in the exercise of the power and authority herein delegated, shall have authority to prohibit the shipment or bringing into this State of any honey bees, honey, honeycomb, or articles or things capable of transmitting contagious or infectious diseases of bees from any State, territory or foreign country, except under such rules and regulations as may be adopted and promulgated by said State Entomologist.

Section 4. All honey bees shipped or moved into this State shall be accompanied by a certificate of inspection signed by the State Entomologist or State Foul Brood Inspector of the State or country from which shipped. Such certificate shall certify to the apparent freedom of the bees, and their combs and hives, from contagious and infectious diseases and must be based upon an actual inspection of the bees themselves within a period of sixty days preceding date of shipment. The shipper of such bees is hereby required to file with the State Entomologist, College Station, Texas, at least ten days in advance of such shipment, a certified copy of said certificate, together with the names and addresses of both consignor and consignee; provided, that when honey bees are to be shipped into this State from other States or countries wherein no official apiary inspector or State Entomologist is available, the State Entomologist of Texas may issue permit for such shipment upon presentation of suitable evidence showing such bees to be free from diseases. Shipments of bees arriving at points within this State, not accompanied by the certificate herein described, shall be subject to confiscation and destruction by the State Entomologist or his assistants. This requirement shall not apply to shipments of live bees in wire cages, when without combs or honey.

Section 5. It shall be unlawful for railroad companies, express companies or other common carriers to accept for shipment, between points within this State, any honey bees, used honey combs, used bee hives or fixtures, except under such regulations and provisions as the State Entomologist shall prescribe.

Section 6. The State Entomologist, through himself, assistants or inspectors, shall have authority to seize and confiscate any shipments of diseased bees found in transit in this State, or found in any depot, ex-

press office, storeroom, car, warehouse or premises awaiting transportation or delivery, and the State Entomologist, through himself or his assistants, shall have authority to enter, during ordinary business hours, any depot, express office, storeroom, car, warehouse, or premises for the purpose of inspecting any shipment of honey bees therein which he may have reason to believe are or may be infected with a contagious or infectious disease or which he may have reason to believe are being transported or have been or are about to be transported in violation to any of the provisions of this Act.

Section 7. In the discharge of the duties herein delegated, the State Entomologist, and his assistants and inspectors, shall have authority to enter, during ordinary business hours, any premises, public or private, wherein may be located any honey bees, or wherein he or they may have reason to believe any honey bees are kept or located, for the purpose of examining said bees and determining whether or not they are infected with any contagious or infectious disease.

Section 8. The State Entomologist shall have authority to declare a protective quarantine in any district, county, precinct or other defined area wherein foul brood or other contagious disease of bees is not known to exist, or wherein any disease of bees is being eradicated in accordance with the provisions of this Act, said quarantine to prohibit the movement or shipment, into said district, county, precinct or any other area, of any bees, honey, appliances or other things capable of transmitting the disease or infection, except under such rules and regulations as he shall prescribe.

Section 9. The State Entomologist shall have authority when, in his opinion, public welfare and necessity require it, to place a restrictive quarantine upon any district, county, precinct, or other defined area wherein are located any honey bees infected with contagious or infectious disease, said quarantine to prohibit the movement or shipment therefrom of any bees, honey, appliances or other things capable of transmitting the infection, except under such rules and regulations as he shall prescribe.

Section 10. Queen bees and their attendant bees shall not be sold or offered for sale in this State unless accompanied by a copy of a certificate from a state or government entomologist or apiary inspector to the effect that the apiary from which said queen bees are shipped has been inspected within the preceding twelve months and found apparently free from contagious and infectious diseases, or by a copy of a statement by the beekeeper made before a notary public or other officer having a seal that the bees are not diseased to the best belief of affiant, and that the honey used in making the candy contained in the queen cage has been diluted and boiled for at least thirty minutes in a closed vessel.

Section 11. Any person, firm or corporation violating any of the provisions of this Act, or violating any of the rules, quarantines, orders or regulations of the State Entomologist issued in accordance with the provisions of this Act, shall be deemed guilty of a misdemeanor, and shall, upon conviction thereof, be fined in any sum not less than twenty-five nor more than two hundred dollars. All prosecutions under this Act shall be commenced and carried on in any county of the State affected by the viola-

tion of said orders, quarantines, rules or regulations, and the said State Entomologist may enjoin any threatened or attempted violation of his orders, quarantine, rules or regulations in any court of competent jurisdiction, or take any other civil proceeding necessary to carry out and enforce the provisions of this Act. It shall be the duty of the Attorney General and the various county and district attorneys to represent said State Entomologist whenever called on to do so; and the said State Entomologist, in the discharge and enforcement of the duties and powers herein delegated, shall have the authority to compel the production for examination by said State Entomologist, or anyone designated by him, of all books, papers and documents in the possession of any person; to take testimony, and compel the attendance and examination under oath of witnesses; and it is hereby made the duty of various sheriffs and constables throughout the State to serve all papers, orders, summons and writs that may be delivered to them by said State Entomologist and to protect the State Entomologist or his assistants or inspectors in the discharge of their duties, as herein defined whenever called upon to do so. The State Entomologist is authorized, when necessary, to apply to any court of competent jurisdiction for the necessary writs and orders to enforce the provisions of this article and in such cases he shall not be required to give bond.

Section 12. For the purpose of disseminating knowledge regarding honey bees and their diseases, the State Entomologist shall publish methods and directions for treating, eradicating or suppressing contagious or infectious diseases of honey bees, including the rules and regulations provided for in Sections 2, 3, 5, 8 and 9, and such other information as he shall deem of value or necessity to the bee keeping interest of the State.

Section 13. If any owner of, or person having control or possession of any honey bees in this State, knows that any bees so owned and controlled are affected with American foul brood, or any other contagious or infectious diseases, or knows of any other bees so diseased, it shall be and is hereby made his duty to at once report such fact to the State Entomologist at College Station, Texas, setting out in his said report all the facts known with reference to said infection.

Section 14. The State Entomologist shall have full power in his discretion to order any owner or possessor of bees dwelling in hives without movable frames, or not permitting of ready examination, to transfer such bees to a movable frame hive within a specified time. In default of such transfer the State Entomologist may destroy, or order destroyed, such hives, together with the honey, frames, combs and bees contained therein, without recompense to the owner, lessee or agent thereof.

Section 15. If at any time the State Entomologist finds, or has reason to believe, that the owner or keeper of any bees, or the owner of any apiaries has refused or is refusing to comply with any or all of the rules and regulations hereinbefore provided for, then and in that event the State Entomologist is hereby authorized to inspect or cause to be inspected said bees, and, if necessary, burn diseased colonies, appliances and honey, and do any and all things necessary in the premises to eradicate foul brood or any other contagious or infectious disease of bees.

Section 16. When any owner or possessor of bees shall fail to carry out instructions of the State Entomologist as hereinbefore set forth, the State Entomologist, or his assistants or inspectors, shall carry out such destruction or treatment and shall present to the owner or possessor of said bees a bill for the actual cost of such destruction or treatment, including the cost of such hives, foundations, etc., as may be necessary for proper treatment of the disease. In the failure of the owner or possessor of such bees to pay said bill within thirty days after the delivery of same to himself, tenant or agent, or within thirty days after mailing same to his usual postoffice address, the State Entomologist shall certify to the county attorney of the county wherein such bees were located, the amount and items of such bill; and the county attorney shall file suit for the recovery of said account. All moneys recovered by the county attorney for such destruction or treatment shall be paid into the hands of the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 17. If any owner or keeper of any diseased colonies of bees shall barter, give away, sell or ship or move any infected bees, honey or appliances, or shall expose any other bees to the danger of infection of the disease, or shall refuse or neglect to make a report as provided in Section 13 of this Act, he shall be deemed guilty of a misdemeanor and upon conviction thereof shall be fined in any sum not less than twenty-five nor more than two hundred dollars.

Section 18. It shall be unlawful for any person, firm or corporation to expose, on their own premises or elsewhere, any honey, hives, frames, combs, brood or appliances known to be infected by foul brood or other dangerous disease of bees, in such a manner that honey bees may have access to same; and it shall be unlawful to sell, offer for sale, barter, give away, ship or distribute any honey taken from a colony or colonies of bees infected with foul brood or other infectious or contagious disease. Violations of this section shall be deemed a misdemeanor and any person, firm or corporation convicted thereof shall be fined in any sum not less than twenty-five or more than two hundred dollars.

Section 19. Anyone who shall seek to prevent any inspection of bees, honey or appliances under the direction of the State Entomologist, in accordance with this Act, or who shall attempt to prevent the discovery or treatment of diseased honey bees, or who shall attempt to intimidate the State Entomologist, or his assistants or his inspectors, or otherwise interfere with them in the lawful discharge of their duties as herein defined shall be deemed guilty of a misdemeanor, and shall, upon conviction, be fined in any sum not less than twenty-five nor more than two hundred dollars. Prosecution under the provision of this section shall be instituted in any county of the State in which the offense is committed.

Section 20. All fines collected for prosecution under the provisions of this Act shall be paid to the State Treasurer, to become a part of the fund for carrying out the provisions of this Act.

Section 21. The State Entomologist, his assistants and inspectors,

shall not be required to give bond or security in any legal proceedings which he or they may institute or defend in any court of justice in this State.

Section 22. All laws or parts of laws in conflict with or inconsistent with this Act be and the same are hereby repealed.

Section 23. The fact that American foul brood now exists and is destroying honey bees in at least twenty-two counties in Texas, and that there is now no adequate statute permitting the immediate suppression and control of this and other contagious diseases of honey bees, creates an emergency and an imperative public necessity requiring the suspension of the constitutional rule which requires bills to be read on three several days, and the same is so suspended, and this Act shall take effect and be in force from and after its passage, and it is so enacted.

Note.—H. B. No. 11 passed the House of Representatives March 8, 1913, but no vote given; passed the Senate by a two-thirds vote, yeas 28, nays 0.

Approved March 27, 1913.

Took effect 90 days after adjournment.

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## REGULATIONS

The following regulations are issued by the State Entomologist in accordance with the GENERAL LAWS OF TEXAS, THIRTY-THIRD LEGISLATURE, Chapter 51, Section 3, commonly known as the "Foulbrood Law".

All regulations previously issued by this office are hereby declared null and void.

**Regulation I.**—It is hereby ordered that on and after March 1, 1922, honey bees in the State of Texas shall be kept only in movable frame hives permitting of ready examination.

The keeping of bees in box hives, gums, logs, barrels, or other domiciles not equipped with movable frames permitting ready examination of all combs, is unlawful. Bees kept in any form of hive except one containing movable frames permitting ready examination are subject to treatment or destruction by the State Entomologist, his assistants, or inspectors, at the owner's expense as provided by Section 16, Chapter 51, General Laws of Texas.

**Regulation II.**—It is hereby ordered that on and after March 1, 1922, no honey bees, used honey combs, used bee hives, used or second-hand apiary fixtures or appliances shall be moved or shipped from one county to another unless they are accompanied by a health certificate or special permit given by the State Entomologist, his assistants, or inspectors.

**Regulation III.**—It is hereby ordered that on and after March 1, 1922, all apiaries or bee yards wherein American Foulbrood is known to exist, are hereby declared to be under quarantine. The removal of any and all bees, queen bees, colonies, nuclei, combs, and apiary appliances or fixtures

is prohibited, except under such cases as the State Entomologist, his assistants, or inspectors may permit or approve. Such quarantine shall exist until such time as the State Entomologist, his assistants, or inspectors shall determine and declare such apiary to be apparently free from American Foulbrood.

**Regulation IV.**—It is hereby ordered that on and after March 1, 1922, no colony or colonies of bees affected with American Foulbrood shall be treated except by permission of or upon the recommendation of the State Entomologist, his assistants, or inspectors.

Given under my hand and seal at College Station, Texas, this first day of February, 1922.

(Signed) M. C. TANQUARY,
State Entomologist.

These regulations remain in effect.

F. L. THOMAS, State Entomologist.
August 24, 1924.

## INFORMATION

Parties wishing to ship or move bees or apiary appliances from one county to another should apply to State Entomologist, College Station, Texas, for a certificate. This application should be made as far as possible in advance of the proposed date of shipping or moving.

10-25-10M

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

W. B. BIZZELL, President

CIRCULAR NO. 37 August, 1925

DIVISION OF AGRONOMY

# SUBTERRANEAN CLOVER--A NEW SANDY-LAND GRAZING CROP FOR SOUTHEASTERN TEXAS

B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

## SUMMARY

Subterranean clover is a fall-sown pasture plant adapted to spring grazing. It has been remarkably successful in Australia.

It has been grown with reasonable success in southeastern Texas. This publication is intended to call it to the attention of farmers in that region.

The plant is adapted to a region of moist, not extremely cold winters.

It is advised that it be fertilized by using 200 pounds of acid phosphate to the acre.

The seed may be sown by itself or on Bermuda sod, or in mixtures, such as rescue grass or rye grass. From one to ten pounds of seed may be planted on an acre of ground.

It should not be over-pastured in the winter.

New areas should be protected until the plant is established, after which it may be expected to reseed itself yearly.

# SUBTERRANEAN CLOVER—A NEW SANDY-LAND GRAZING CROP FOR SOUTHEASTERN TEXAS

A. H. Leidigh, Assistant Director

Subterranean clover (*Trifolium subterraneum*) is an annual legume adapted to grazing. In many ways it resembles bur clover, the use of which was fostered in Texas by the Texas Agricultural Experiment Station many years ago.

The first seed of Subterranean clover, T. S. No. 6035,* grown in Texas was received by the Texas Agricultural Experiment Station on May 3, 1921, from Robert Nicholson, Dallas, Texas, with the request that it be tested in the field. All plantings made from this seed were failures, probably on account of being planted too late in the spring. Mr. Nicholson states that he secured this seed from Australia.

In October, 1921, a small amount of seed of Subterranean clover was received from the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, Washington, D. C., to which was assigned T. S. No. 6466. Seeds from this lot were sent for planting to several of the Substations of the Texas Agricultural Experiment Station. Other seed, T. S. No. 6644, was secured from the same source in September, 1922. As a result of the several tests and trials made with the plant it can be said that it is a very promising new grazing-crop plant.

Subterranean clover is especially valuable as a pasture crop and is probably adapted to southeastern Texas. It remains green twenty to thirty days later in the early summer than does bur clover. It reseeds itself, burying part of the seed crop in the ground ready to germinate when fall rains occur, and it may be said to be almost as permanent a plant when once established, as if it were a perennial. It is not extremely drouth-resistant. It appears to be worthy of extensive trial in southeastern Texas, and for that reason this circular has been prepared to bring it to the attention of farmers.

## DESCRIPTION

Subterranean clover was described by Linnaeus in his "*Species Plantarum*", issued in 1753. He called it an annual. In 1875 Michel Gandoger described it in **Flore Lyonnaise et Des Departements Du Sud-Est** and called it a perennial. Some botanists term it "Self Sown Clover", others "Carpet Forming." It appears to be fairly widespread throughout the Mediterranean regions and occurs also in the Azore Islands. The

*For convenience, a Texas Agricultural Experiment Station accession number is designated herein as "T. S. No."

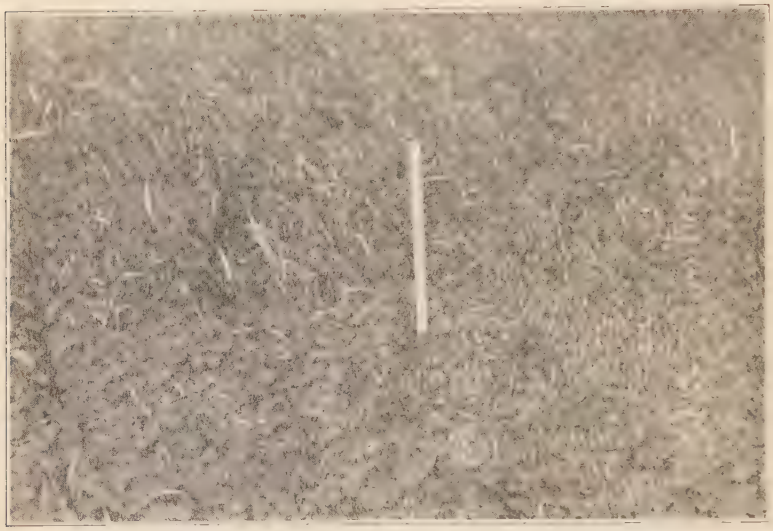

Figure 1. Subterranean clover College Station, Texas. The mat of plant growth is nine inches thick, growing as volunteer or self-sown plants.

writer is not aware of its extensive use in these regions, and Spafford, in Bulletin No. 181, Department of Agriculture, South Australia, states that it has been known for a long time in Central and Southern Europe, being looked upon as a roadside weed.

When grown in Texas, Subterranean clover may be described as follows: It is a true clover, a low-growing, running annual. In this climate, from self-sown seed, it germinates with the coming of the autumn rains in September or October, or may germinate later, lives through the winter, makes a strong, vigorous growth in the spring and early summer, makes seed and then dies before midsummer. The young plant usually attains a height of about three inches by midwinter, and at that time consists of leaves and leaf stalks, but no prostrate stems. In this condition, it has successfully withstood temperatures of eighteen degrees F. with only a slight "burning" or frosting of the edges of the leaves. With the coming of warm weather in March the growth of the plant proceeds rapidly, and by May prostrate branches or runners are thrown out, sometimes three to three and one-half feet long. A single plant sometimes covers several square feet of surface, in which case it makes a dense mass of growth six to ten inches deep. Where there is a heavy stand of clover it has the appearance of a carpet of leaves. Below this are the leafstalks, and then near the surface of the ground a mass of interlaced stems about two or three inches deep. It blooms in April and May and dies in June and July. Where bur clover may ripen and wither by June 1 to 10, the Subterranean clover should remain green until July 1 to 5.

Figure 2. Subterranean clover plant, showing method of flowering.

The Subterranean clover plant is somewhat hairy, with prostrate, slightly thickened stems. The leaves are borne on long, erect, slender stems above the prostrate runners. There are three leaflets on each leafstalk. The leaf is usually one to one and one-half inches across. The flower clusters are borne on stalks shorter than the leafstalks and spring from the axils of the leafstalks. There are usually four flowers in each cluster, but sometimes three or five. These are of a yellowish-white or an ivory-white color with a pink tinge. As the seeds develop, a head is formed, made up of a group of forked hairs equally spaced around the center at the end of the flowerstalk and outside of the seed. The hairs of the head soon become thickened and tough, with sub-branches, and may be called bristles. The direction of slope of these bristles from their point of attachment to the stem is such as to give a blunt pointed mass of turned-back bristles surrounding the seed pods. This is called the seed head. The head has an anchoring or holding function and serves not only to surround the seeds, but to retain them in the soil or in the mass of stems. There is one seed in a pod and usually three to five pods in a head. The pod is a soft tissue or fibrous covering about the seed, protected by the bristles. The ripening seed-heads tend to point downward, and many of these bury themselves in the earth by what is evidently a "pegging" action somewhat similar to that of the peanut. Thus, many of the seed-heads are buried in the soil, and even with the removal of the dead growth when the plant ripens these heads remain in the soil, being held by the bristles and their forked structure. With a heavy stand and a moist climate, many of the seed-heads remain near the base of the matted growth, being above or on the surface

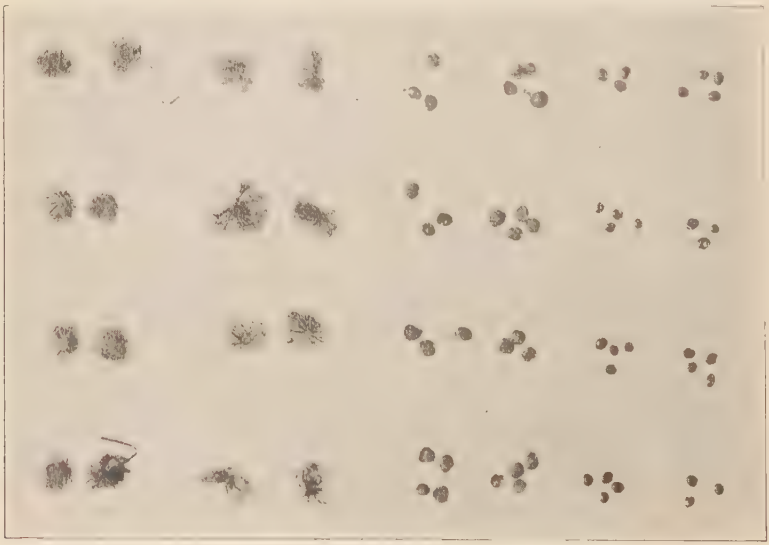

Figure 3. Seed heads, pods and seed of Subterranean clover, approximately one-half natural size.

of the ground and can be recovered or harvested quite easily by gathering up the mature plants.

The seeds of Subterranean clover are a brilliant dark purple in color, 1.5 to 2.5 millimeters long, 2 to 3 millimeters wide, and about 1.75 millimeters thick. The radicle is large and the appearance of the seed in general is round. The radicle sometimes is visible through the ruptured seed coat.

The production of clystagmous seed is not one of the characteristics of this clover, so far as the writer has been able to learn from the available literature. In the spring of 1924, samples from a field at College Station showed at least one plant that bore what appeared to be clystagmous seeds. In the ripe plants the occurrence of seed-pods attached to the root of the plant below the surface of the ground also supported this idea, even though no seeds were present. It is probable that the original name of Linnaeus referred to the pegged seed, rather than to clystagmous seed.

## RESULTS OF TRIALS IN SOUTHEASTERN TEXAS

Subterranean clover has given good results for three years in succession at three points in southeastern Texas. At College Station it was planted in the fall of 1921, and thereafter grew in 1922, 1923, and 1924 from self-sown seed. The original small plot had increased to several times its original size by 1924 without any cultivation or care. In 1924, some of the plants so grown produced runners more than thirty-eight inches long. In the dry weather of the spring of 1925 the volunteer plants, being on hard ground not plowed for some years and near a group of trees, died on account of lack of moisture, but on cultivated ground a new seeding made in the fall of 1924 produced a small growth and was harvested for seed. The plant in general appears to be much more vigorous and a much heavier yielder of leaves than is bur clover. The soil here is Lufkin fine sandy loam, an upland fine sandy loam, underlain by a heavy, dense, plastic, almost impermeable clay soil at a depth of a few inches.

At Substation No. 11, Nacogdoches, on Orangeburg fine sandy loam, this clover was from a medium success to a marked success in 1922, 1923, and 1924, and it reseeded itself. In 1925 the clover suffered very seriously on account of the dry weather in the spring.

At Substation No. 4, Beaumont, Subterranean clover planted in the fall of 1921 established itself and persisted on uncultivated land in roadways where the prevailing growth was Bermuda grass and lespedeza. The soil there is known as Crowley clay, a very heavy soil adapted to rice production. The drainage is poor. On cultivated land on Substation No. 4, the clover has been planted in slightly ridged rows, and considerable seed has been gathered for extending the area. The Subterranean clover plant is not especially drouth-resistant, and in 1925 it was seriously checked by the dry season.

At Substation No. 3, Angleton, Subterranean clover seeded in the spring of 1923 made a good growth and produced seed. At Substation No. 8, Lubbock, under supplemental irrigation, three trials resulted in no especial success.

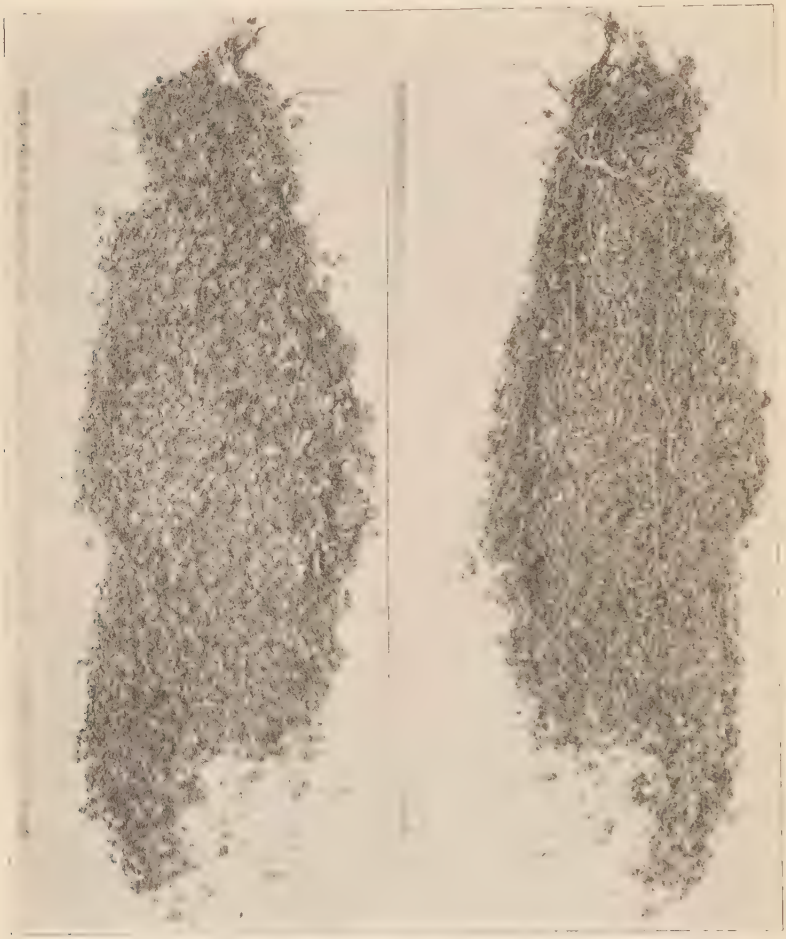

Figure 4. Subterranean clover plants suspended by the roots. Left: Upper side of plant. Right: Lower side of plant showing burrs. The ruler shown in picture is thirty-six inches long. From a volunteer crop of 1924, College Station.

As a result of the work at College Station, Nacogdoches, Beaumont, and Angleton, the following further statements can be made: The crop has been grown in rows and in broadcast plats. It has shown the remarkable quality of practically smothering out weeds and grasses, and in this respect it is unique among winter and spring pasture plants of any value at these places. It is not known what effect it will have on bur clover. Thus far, rescue grass, which comes up at practically the same time in the fall and is much taller, is the only plant that has appeared not to be almost entirely suppressed by it. As it is grown in Australia in mix-

tures with other clovers and grasses, especially in mixtures with rye grass, it would appear that rye grass and rescue grass should be tried in mixtures with the Subterranean clover. Subterranean clover, on account of its dense growth, may possibly much more nearly hold Bermuda grass in check until midsummer than will bur clover. It makes a much heavier and more dense shade than bur clover and remains on the land until after Bermuda grass should have made its first heavy spring growth. In those parts of Texas where the winters are long and open, and usually moist, with dry summers, the crop, in addition to its use as a green pasture, may be expected to be of value in the summer as a dry forage on the ground.

Nothing is known as to the presence of the proper strain of nitrogen-fixing bacteria inoculation in our soils for Subterranean clover, but the United States Department of Agriculture has supplied us with material for insuring the inoculation, and our clover was well supplied with nodules.

No data are available concerning the chemical analysis and feeding value of Subterranean clover, except the practical information from Australia. It should be of value as a nitrogenous feed crop and as a crop for maintenance of soil fertility where pasture can be used, and where it is grown in mixtures with grasses.

Deep plowing in the summer and winter at College Station has practically destroyed Subterranean clover, and, therefore, no fear need be felt of its becoming a troublesome weed. Our experiments have established the fact that this plant is adapted to our conditions and will grow here, but it is felt that we have not experimented with it a sufficient length of time to have information on all phases of its culture and usefulness. For that reason, it seems advisable to present here information from other sources.

## OTHER OBSERVATIONS

The following brief observations are secured from Bulletin No. 181, "Subterranean Clover", 1924, Department of Agriculture, South Australia, by W. J. Spafford:

> The plant has been grown in South Australia about thirty years. In recent years it has become an important pasture crop, especially in regions having 25 to 40 inches of rainfall per annum. (College Station, Texas, has about 37 inches of rainfall per annum). Seeding is done in the fall. It is usually not necessary to reseed in later years on permanent pasture. The plant frequently attains a height of 15 to 20 inches. It is grown on a wide range of soils, and is useful on sour soils. The use of phosphate fertilizers is advised. The plant is used for grazing, both as a green and as a dry field-cured crop. It is also cut for hay. Cattle and sheep may bloat on Subterranean clover, but it is no worse in this regard than other clovers. The plant should not be grazed too heavily in the winter. It withstands heavy grazing when making a rapid growth in the warm part of the spring. When dead and dry on the ground the livestock will eat up the crop clean. When dry on the ground, it may be grazed heavily without much danger of a loss of stand the next year, this being due to the buried seeds. It is recognized as a "wonderful cleaner of the soil", (just as we have noted here at College Station), in that it chokes out weeds and grasses. It is advised that the fields be harrowed in the late summer. Only one injurious insect has been noted, this being the so-called Lucerne flea (**Smynthurus viridis**), (an insect not known to be present in the United States).

The following observations are secured from "Fodder Crops for Australia," by Leslie H. Brunning, Melbourne:

Subterranean clover is an extremely valuable grazing plant, greatly increasing the carrying capacity of cattle and sheep pasture. It is well liked by stock. A self-seeded field may appear bare in the summer, but growth starts with the first rain. It spreads rapidly. It is a weed suppresser. It is not an especially good drouth resister. It will grow on land that is sour, and especially "second class land and dry hill country." Phosphate is recommended as fertilizer. As little as two pounds of seed may be used to get a start on an acre of land, if it is to remain for several years in pasture. From five to seven pounds of seed is recommended, however. Sometimes success is attained from spring seeding. In cutting with a mower, it should not be harvested too close if the stand is thin. The seed should not be buried over about one-half an inch deep in planting.

The following observations are secured from The Journal of the Department of Agriculture of Western Australia, December, 1924, "Subterranean Clover", by A. B. Adams:

There are three types or varieties of Subterranean clover. These are the early, the medium, and the late flowering. The medium flowering is the kind that has become so very valuable and generally grown. Its leaves are plentiful, stalks stronger and thicker. The flower has red markings in the calyx. The leaves have white V-shaped markings and often brown flecks. (This appears to be the kind grown by the Texas Agricultural Experiment Station and described herewith). The early flowering type is said to be sparsely leaved and possibly adapted to a drier location. The late sort is large and has no markings on the leaves.

From various periodicals, the following additional material has been gathered regarding the growing and use of Subterranean clover in Australia:

Subterranena clover grows there in mixtures. (Several of the grasses and clovers occurring in these mixtures will grow in southeastern Texas). In these Australian regions, such crops and trees as grapes, oranges, corn, cowpeas, cotton, and similar crop plants are commonly grown. It is greatly increasing the carrying capacity of the pastures. It is advised by some that it be planted very sparingly the first year, say at the rate of two pounds of seed to the acre, along with a cover crop, so that the crop may be harvested for hay and the clover left to seed the land. If cattle graze on a thin stand the first year it is planted, they may pull up the long runners and very largely prevent reseeding. After it is once established on the land, this need not be feared, if good management is given.

## PROBABLE ADAPTATION

Subterranean clover deserves careful trial by farmers in southeastern Texas. The present information justifies the recommendation that it be tried in the entire south and east part of the State as far northward as a line drawn through Eagle Pass, San Antonio, Hearne, Palestine and Nacogdoches.

## SEED AND SEED PRODUCTION

Seed supplies at this time are very limited, and seed may be worth as much as one to two dollars a pound, when purchased in small quantities. The Texas Agricultural Experiment Station has informed seedsmen of the success of this plant, and it is hoped that they will have arranged to import sufficient seed to get the plant established.

Subterranean clover seed for home use may be saved with very little expense and labor, once the crop is established. The ripe plants may be carefully raked up by hand, cured in small piles or stacks and the seed threshed out with flails. Much seed can be swept up from the surface soil. It will be found that nearly one-half the seed crop is partly buried in the surface of the soil. The seed need not be threshed out of the heads or pods,

if for home use. Where a considerable area has been successfully established, seed may be secured by merely raking up the dry, cured plants into bunches with a horse rake and threshing them through an ordinary thresher. If a thresher is not available and the material is very dry, most of the seed may be saved by the use of a pea huller. Seed for market must, of course, be run through a clover huller, set and adjusted for this species of clover, the seeds of which are somewhat larger than are those of other clovers commonly grown in this region. Seed not threshed may show as little as twenty per cent germination, due to hard seed, and of the remaining eighty per cent about half may be expected to germinate that season. Machine-threshed seed may be expected to show eighty per cent or more germination.

The following figures were obtained from some comparatively clean Subterranean clover seed taken from a sample collected June 1, 1924, at College Station. The seed-pods were comparatively clean, although they contained quite a bit of dirt:

| Material | Per Cent by Weight |
|---|---|
| Dirt and trash | 21 |
| Outer or coarse covering of seed-head, bristles | 33 |
| Fibrous covering only, empty pods | 9 |
| Clean seed | 37 |
| Total | 100 |

## GROWING THE CROP IN TEXAS

Trials with Subterranean clover, except on a very small scale, should not be attempted anywhere in Texas except in the southeast. This limit is estimated on the basis of experiments carried out thus far, and is because of climatic conditions.

Subterranean clover is adapted to a wide range of soils, but may be expected to succeed best on sandy loams or fine sandy loams. On heavier or rather poorly drained soils care must be used to provide reasonable surface drainage. It may be expected to be a good plant for trial on much of the cut-over sandy lands of southeastern Texas, except the dry sand or sand hills. Subterranean clover should probably be seeded as follows:

(1) Where a cotton field is to be seeded in September, the seed should be broadcast and lightly harrowed so as to be covered one-fourth inch deep. Use six to ten pounds of seed to the acre on small areas, or one to two pounds of seed to the acre on large areas.

(2) If the clover is to be sowed with oats on cultivated land, the seed should be broadcast after the seed oats have been covered. Usually the land will be rough, and when the rains come the clover seed will be covered. If such a field is very smooth, a very light harrowing to cover the seed one-fourth inch deep may be given after the clover seed are scattered. Use six to ten pounds of seed to the acre on small areas.

(3) If cut-over land or land having deadened trees on it is to be used, the seed should be sowed early at the rate of four pounds to the acre. If possible, harrow lightly or drag with a brush drag. If large areas are desired to be kept in pasture, it may be best to select favorable locations and protect them against stock so as to secure a start of clover.

(4) Where grass land is used, scatter one or two pounds of seed to the acre.

Judging by other clover varieties, it may be suggested that the farmer will do well to make his initial trial of Subterranean clover on and about an abandoned feed pen or cow lot.

The amount of seed to sow is largely dependent on the cost of the seed. If only a small area is to be seeded and protected thereafter as a source of home-grown seed, it will be well to sow the seed at the rate of six to ten pounds of clean seed to the acre. If a field, as of oats or cotton or stump land, is to be seeded for permanent pasture, as suggested, only one or two pounds of clean seed will be needed.

Where home-grown seed is available, it would appear that it will require from three to eight pounds of seed in the head to equal the germination of one to two pounds of threshed seed. As figures given previously show that probably 37 per cent or less of clean seed are contained in the head, it will be seen that perhaps as much as twenty-five pounds of sweepings will be required to secure a stand on an acre. As ordinarily secured, twenty-five pounds of sweepings will be about what can be gathered in three feed sacks.

The time of sowing is preferably during the month of September. Under any and all conditions in southeastern Texas, at least 200 pounds of acid phosphate to the acre should be applied to the land just before or immediately after sowing and probably one-half that much per annum thereafter. When seeding Subterranean clover under any of the conditions just mentioned, it is suggested that other clovers, as well as grasses be seeded at the same time.

Subterranean clover pasture should not be too heavily grazed in the fall and winter. In case of newly seeded areas, care will have to be exercised to see that the land is not grazed too heavily. Its production period is in the spring, at which time, if conditions of weather are favorable, it may be expected to be a very heavy producer and will carry a large number of grazing animals per acre.

## ACKNOWLEDGMENTS

The author acknowledges assistance in securing field data from the Superintendents of Substations as follows: G. T. McNess, No. 11, Nacogdoches; A. H. Prince and later R. H. Wyche, No. 4, Beaumont; V. E. Hafner, No. 3, Angleton; R. E. Karper, No. 8, Lubbock; and G. N. Stroman and later D. T. Killough of the Main Station Farm at College Station.

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327 An Agricultural Economic Survey of Rockwall County Texas.
329 Energy Production Coefficients of American Feeding Stuffs.
330 Farm Mortgage Financing in Texas.
332 Biometrical Studies of Lint and Seed Characters in Cotton.
333 Heritable Chlorophyll Deficiencies in Seedling Cotton.
335 Commercial Fertilizers in 1924-25.

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1 Strawberries Under Irrigation in South Texas—1914.
7 Insect Enemies of Sudan Grass—1915.
10 Housing Farm Implements—1015.
22 The Malvaceous Plants of Texas—1920.
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34 The Lower Rio Grande Valley of Texas.
35 Suggestions on Queen Rearing.
36 Foulbrood Control and Diseases of Bees—Foulbrood Law and Revised Regulations.

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11-25-11M

TEXAS AGRICULTURAL EXPERIMENT STATION

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS

T. O. WALTON, President

CIRCULAR NO. 38 September, 1925

DIVISION OF ENTOMOLOGY

# BIENNIAL REPORT OF APIARY INSPECTION 1923-1925

B. YOUNGBLOOD, DIRECTOR

COLLEGE STATION, BRAZOS COUNTY, TEXAS

## SYNOPSIS

A short account is given of the methods and equipment used in examining colonies of bees when inspected for the more serious brood diseases. The policy of burning diseased colonies is generally followed, as it has proved to be the safest and cheapest method of combating American foulbrood in the South.

More than 38,000 colonies were inspected in 1923-1924 and in 1924-1925 nearly 42,000 were examined. Only about one per cent were found to be infected with American foulbrood.

The report also contains concise information on preventing the spread of this disease.

Circular No. 38 September, 1925

# BIENNIAL REPORT OF APIARY INSPECTION WORK, 1923-1925

by

C. S. Rude, Chief Foulbrood Inspector

The work of inspecting colonies of bees for foulbrood and other contagious diseases has been carried on under the provisions of the State Foulbrood Law since 1905, excepting three years. A report of the work done up to August 31, 1923, appears in Circular 36 of the Texas Agricultural Experiment Station.

The present circular inaugurates the plan to issue a biennial report By means of such periodic reports the beekeepers and others who are interested will be better able to keep themselves posted with reference to the foulbrood situation in Texas and will from time to time receive information that may be of value in combating the dangerous diseases of bees.

## HOW AMERICAN FOULBROOD IS SPREAD

Whenever the disease breaks out in new territory inspectors always seek to determine the source of the new outbreak. In several cases the origin of American foulbrood has been traced to second-hand honey cans. In at least two other cases the centers of the diseased areas have seemed to be establishments that were rebottling honey. In one such case honey cans were found on the dump pile with bees robbing them. This is of course only circumstantial evidence but all the American foulbrood found in that territory was within a radius of one mile of this dump pile.

Another common source of disease is second-hand equipment. It is unsafe to use even a single frame of which the entire history is not known.

Disease is also often spread as the result of carelessness on the part of the beekeeper and his ignorance as to the nature of the disease. The time to learn of American foulbrood is before it gets into the apiary. A few hours spent studying the disease and its nature may save many hours of disagreeable and expensive work.

### "Don'ts"

Don't scatter bits of comb and honey about the yard even though you think your bees are free from disease. To do so may spread American foulbrood.

Don't feed honey to your bees unless you positively know it came from clean bees. When in doubt, feed sugar, as it is a better feed and does not start robbing as quickly.

Don't buy second-hand honey cans.

Don't buy second-hand equipment.

Don't exchange combs without first examining them for American foulbrood.

Don't take chances. If your bees get American foulbrood, burn them up. It is cheaper in the long run.

Don't practice false economy. A doubtful small saving may result in ultimate ruin.

HELPS FOR IDENTIFYING DISEASES

The available space will not allow of a detailed discussion of all of the brood diseases. However, it has been considered advisable to include here the more important and noticeable characteristics of the three most prevalent brood disorders. These have been arranged in tabular form and it is hoped will prove of assistance in diagnosing brood diseases.

| | American Foulbrood | European Foulbrood | Sac Brood |
|---|---|---|---|
| Cause | Bacillus larvae | Bacillus pluton | Filterable virus |
| Cappings | Often sunken, discolored and perforated | Usually not sealed | Sunken and perforated |
| Age of larvae | Usually die after capping | Usually die before capping | Die after capping |
| Color | Dark brown | Lemon yellow to gray | Dark brown |
| Consistency | Glue-like, ropy | Soft, moist, often slimy | Watery and granular |
| Cuticle | Disintegrates. Brood sticks to cell | Tough. Brood does not stick to cell | Intact, tough, brood does not stick to cell |
| Position in cell | Lengthwise on lower side wall. Soon becomes shapeless | Usually curled at bottom of cell | Lengthwise on lower side wall. Gondola-shaped |
| Scales | Dark brown. Adhere tightly to cell | Yellow to brown. Free at bottom of cell | Dark brown. Free |
| Brood affected | Usually worker; may affect queen and drone brood | Worker, drone and queen | Worker |

## METHOD OF MAKING INSPECTIONS

In spring, the field work usually begins the first of February and includes the inspection of colonies belonging to queen breeders. The summer months are occupied by the inspection of colonies of honey producers and in the fall a re-inspection of quarantined apiaries lasts as long as weather conditions permit.

In making an inspection, all brood combs of each colony in the apiary are examined. The comb is raised out of the hive and the side next to the observer is examined carefully for disease. It is then turned so as to examine the other side in like manner. If as much as one cell of American foulbrood is found, the colony is immediately closed up and marked. The inspector then disinfects any implements that may have been contaminated, as well as his hands and such parts of his clothing as may have come in contact with diseased material. A solution of bichloride of mercury is used as a disinfecting bath.

A plan of area clean-up is now in use. As soon as a case of foulbrood is located, a careful inspection of the surrounding territory is made. All colonies that can be found are examined, the work being conducted in ever increasing distances with the diseased yard as a center. The policy of burning diseased colonies is generally followed, as it has proved to be the safest and cheapest method of combating American foulbrood. All of the 408 colonies found infected with this disease in 1924-1925 were destroyed by fire.

To burn a colony or colonies, a pit is dug about 12 to 18 inches deep and of sufficient size to hold the material to be burned and to allow about 12 inches on all sides. The entrances to the hives are securely closed and the hives are placed in the pit; kindling and wood is piled around them and a little oil is poured over the pile. A fire is then started and as the hives burn down, the pile is stirred from time to time to insure complete burning. When the burning has been completed, the pit should be filled in with dirt to insure no diseased material being left exposed to robber bees. Destruction of the colonies should take place at night except when conditions are such that practically no danger of spreading the disease is incurred if burned during the day. This decision is left to the inspector.

## EQUIPMENT OF INSPECTORS

A Ford touring car has been found indispensable. The inspectors are thereby better enabled to accomplish the plan of area clean-up when dis-

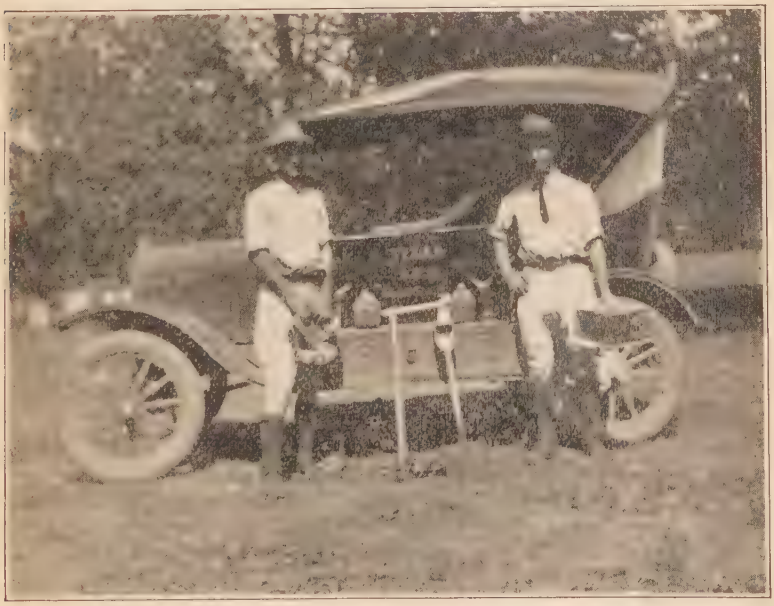

Figure 1. State car used in foulbrood inspection, showing equipment carried.

ease is found. They are not dependent on the beekeeper or service car for local transportation nor are they held up by train schedules.

The car is used only for necessary travel and is equipped with a dependable speedometer, which has made it possible to arrive at a definite knowledge of the distance traveled during the year or in any section of the State. The driver is required to send in a weekly itemized report of the operation of the car showing all expenditures as well as the mileage traveled in the vicinity of and between points where inspections are made. Including a depreciation of fifty per cent in the car, the cost of running the automobile has been 3.5 cents per mile. Two and sometimes three men travel together.

Other necessary equipment consists of a spade, mattock, hand ax, smokers, veils, hive-tools, canteens, pail, and disinfectant. The spade and mattock are used to dig pits in which to destroy diseased colonies. The hand ax is used in cutting kindling and wood for burning disease. The pail is for use in disinfecting after foulbrood has been found. The smokers, veils, and hive-tools are used in the regular work of examining the colonies. It is the plan to have the inspector as little dependent on the beekeeper as possible.

## REPORT OF INSPECTION WORK

Prior to the year ending August 31, 1911, the work in foulbrood control, while more or less preliminary, was valuable in that it located the major diseased areas and formed a basis for further work.

### Inspections of Queen Rearing Yards

In connection with the regular inspection it is also necessary to inspect the apiaries of parties who wish to ship or sell queen bees. In 1923-1924, forty such apiaries were inspected containing a total of 13,284 colonies. In 1924-1925, forty queen breeding apiaries were inspected with a total of 14,871 colonies.

In shipping queens, a copy of a queen breeder's certificate is required on each package. It has been customary in the past to issue the certificate and to permit the queen breeder to have copies printed wherever he chose. The lack of uniformity in these copies, however, was so striking as to cause considerable confusion at express and post offices. In some few cases shipments were refused on account of the certificates not being in an acceptable form. In order to avoid such conditions it was decided that the Division of Entomology should have the copies printed and distribute them to the queen-breeders, at a price that would just cover the expense. During the season of 1924-1925, the Division of Entomology furnished 11,500 copies at a cost of 40 cents per hundred. This plan, now working very smoothly, is giving the hoped-for relief and will be continued in the future.

The inspection of queen breeding apiaries reduces the possibility of the spread of disease by preventing the shipping of bees and queens from infected apiaries.

## General Inspection

The following table shows a summary of the work that has been done since the year ending August 31, 1910. In all tables the year is considered as beginning September 1 and ending August 31, in conformity with the fiscal calendar.

TABLE 1

Summary by years of inspection work September 1, 1910 to August 31, 1925

| Date | Number of Colonies | | | | | Number of counties worked |
|---|---|---|---|---|---|---|
| | | American Foulbrood | | | | |
| | Examined | Found | Treated | Destroyed | Unaccounted for | |
| 1910-1911 | 19863 | 270 | 178 | 75 | 17 | 9 |
| 1911-1912 | 31819 | 283 | 230 | 53 | 0 | 11 |
| 1912-1913 | 19775 | 323 | 211 | 85 | 27 | 17 |
| 1913-1914** | 0 | 0 | 0 | 0 | 0 | 0 |
| 1914-1915 | 12017 | 341 | 154 | 66 | 121 | 18 |
| 1915-1916 | 45621 | 574 | 238 | 165 | 171 | 25 |
| 1916-1917 | 22665 | 224 | 126 | 54 | 44 | 22 |
| 1917-1918 | 38648 | 398 | 147 | 177 | 74 | 21 |
| 1918-1919 | 35615 | 401 | 191 | 110 | 100 | 44 |
| 1919-1920 | 25676 | 687 | 156 | 515 | 16 | 35 |
| 1920-1921 | 39741 | 499 | 60 | 439 | 0 | 55 |
| 1921-1922 | 45530 | 618 | 77 | 541 | 0 | 65 |
| 1922-1923 | 42960 | 334 | 13 | 321 | 0 | 60 |
| 1923-1924 | 38037 | 411 | 14 | 397 | 0 | 63 |
| 1924-1925 | 40557 | 408 | 0 | 408 | 0 | 67 |

**No appropriation made.

A sample of infected brood sent from Dallas, Texas, to Washington, D. C. in 1924, was diagnosed as European foulbrood. This is the first and only record of that disease found in the State. The territory from which this sample was sent was thoroughly inspected shortly afterwards by competent inspectors and no other cases were found.

The distribution of American foulbrood in Texas is shown by the map in Figure 2. The areas in black indicate those counties where American foulbrood was found in 1925. The shaded areas show the counties in which American foulbrood has been found but which were free of disease in 1925. The double-shaded areas show the counties in which American foulbrood was found in 1924, but which were not inspected during the year 1924-1925.

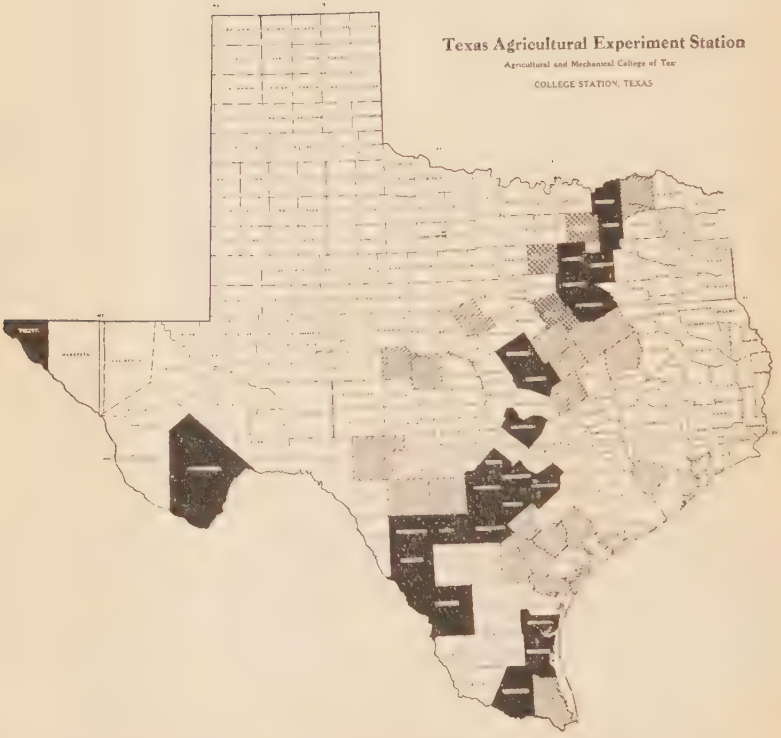


**Figure 2. Distribution of American foulbrood in Texas. Counties in black are those in which disease was found in 1924-1925. Shaded areas show where disease has been eliminated. Double-shaded areas show disease territory not inspected by August 31, 1925.**

TABLE 2
Summary of inspection work by counties for the year 1923-1924

| County | Number of Colonies | | | | | |
|---|---|---|---|---|---|---|
| | | American Foulbrood | | | | |
| | Examined | Found | Treated | Destroyed | Cross-comb | Transferred |
| Atascosa | 3068 | 60 | 0 | 60 | 29 | 0 |
| Austin | 130 | 0 | 0 | 0 | 0 | 0 |
| Bastrop | 82 | 0 | 0 | 0 | 2 | 2 |
| Bee | 815 | 0 | 0 | 0 | 0 | 0 |
| Bell | 219 | 0 | 0 | 0 | 0 | 0 |
| Bexar | 1459 | 69 | 0 | 69 | 3 | 0 |
| Brazoria | 132 | 0 | 0 | 0 | 0 | 0 |
| Brazos | 80 | 0 | 0 | 0 | 3 | 3 |
| Brooks | 205 | 0 | 0 | 0 | 0 | 0 |
| Caldwell | 1248 | 0 | 0 | 0 | 0 | 0 |
| Cameron | 910 | 0 | 0 | 0 | 20 | 0 |
| Collin | 759 | 24 | 0 | 24 | 67 | 0 |
| Colorado | 56 | 0 | 0 | 0 | 0 | 0 |
| Comal | 291 | 6 | 0 | 6 | 4 | 0 |
| Concho | 155 | 10 | 0 | 10 | 22 | 0 |
| Coryell | 29 | 3 | 0 | 3 | 0 | 0 |
| Dallas | 837 | 6 | 0 | 6 | 44 | 3 |
| Delta | 102 | 0 | 0 | 0 | 0 | 0 |
| Dimmit | 1050 | 11 | 0 | 11 | 0 | 0 |
| Duval | 165 | 0 | 0 | 0 | 0 | 0 |
| Ellis | 1820 | 6 | 0 | 6 | 77 | 83** |
| El Paso | 182 | 0 | 0 | 0 | 0 | 0 |
| Fannin | 355 | 14 | 0 | 14 | 41 | 0 |
| Fort Bend | 345 | 11 | 5 | 6 | 0 | 0 |
| Frio | 2810 | 13 | 0 | 13 | 0 | 0 |
| Goliad | 502 | 0 | 0 | 0 | 0 | 0 |
| Grimes | 91 | 0 | 0 | 0 | 0 | 0 |
| Guadalupe | 635 | 1 | 0 | 1 | 0 | 0 |
| Hidalgo | 2286 | 47 | 0 | 47 | 59 | 1 |
| Hill | 547 | 12 | 0 | 12 | 112 | 0 |
| Hunt | 820 | 9 | 0 | 9 | 14 | 0 |
| Jackson | 44 | 0 | 0 | 0 | 0 | 0 |
| Jim Hogg | 200 | 0 | 0 | 0 | 0 | 0 |
| Jim Wells | 300 | 0 | 0 | 0 | 0 | 0 |
| Johnson | 104 | 0 | 0 | 0 | 0 | 0 |
| Kaufman | 163 | 6 | 0 | 6 | 0 | 0 |
| Kimble | 608 | 0 | 0 | 0 | 0 | 0 |
| Lamar | 440 | 0 | 0 | 0 | 0 | 0 |
| Leon | 257 | 0 | 0 | 0 | 0 | 0 |
| Limestone | 344 | 0 | 0 | 0 | 7 | 0 |
| Live Oak | 286 | 0 | 0 | 0 | 0 | 0 |
| Matagorda | 653 | 0 | 0 | 0 | 0 | 0 |
| McCulloch | 818 | 1 | 0 | 1 | 64 | 29 |
| McLennan | 812 | 2 | 0 | 2 | 4 | 2 |
| Milam | 47 | 0 | 0 | 0 | 0 | 0 |
| Mills | 700 | 0 | 0 | 0 | 3 | 1 |
| Navarro | 1821 | 31 | 0 | 31 | 152 | 44 |
| Nueces | 1090 | 0 | 0 | 0 | 0 | 0 |
| Red River | 131 | 0 | 0 | 0 | 0 | 0 |
| Robertson | 64 | 0 | 0 | 0 | 0 | 0 |
| San Patricio | 505 | 0 | 0 | 0 | 0 | 0 |
| Tarrant | 161 | 8 | 0 | 8 | 15 | 0 |
| Travis | 320 | 15 | 0 | 15 | 6 | 0 |
| Uvalde | 1148 | 0 | 0 | 0 | 0 | 0 |
| Van Zandt | 11 | 0 | 0 | 0 | 10 | 0 |
| Victoria | 290 | 0 | 0 | 0 | 8 | 0 |
| Ward | 20 | 0 | 0 | 0 | 0 | 0 |
| Webb | 230 | 9 | 9 | 0 | 0 | 0 |
| Wharton | 954 | 0 | 0 | 0 | 0 | 0 |
| Willacy | 464 | 0 | 0 | 0 | 35 | 0 |
| Williamson | 1863 | 0 | 0 | 0 | 75 | 0 |
| Wilson | 575 | 34 | 0 | 34 | 11 | 1 |
| Zavalla | 429 | 3 | 0 | 3 | 0 | 0 |
| Total | 38037 | 411 | 14 | 397 | 887 | 169 |

**Due to reporting transfers that were ordered in 1922-1923.

TABLE 3
Summary of inspection work by counties for the year 1924-1925

| County | Number of Colonies | | | | | |
|---|---|---|---|---|---|---|
| | | American Foulbrood | | | | |
| | Examined | Found | Treated | Destroyed | Cross-comb | Transferred |
| Anderson | 237 | 0 | 0 | 0 | 0 | 0 |
| Atascosa | 2025 | 9 | 0 | 9 | 5 | 0 |
| Bandera | 64 | 0 | 0 | 0 | 0 | 0 |
| Bee | 252 | 0 | 0 | 0 | 0 | 0 |
| Bell | 2029 | 13 | 0 | 13 | 2 | 0 |
| Bexar | 1955 | 11 | 0 | 11 | 10 | 0 |
| Brazoria | 118 | 0 | 0 | 0 | 0 | 0 |
| Brazos | 31 | 0 | 0 | 0 | 0 | 0 |
| Brewster | 297 | 5 | 0 | 5 | 0 | 0 |
| Brooks | 69 | 0 | 0 | 0 | 0 | 0 |
| Caldwell | 1235 | 0 | 0 | 0 | 0 | 0 |
| Cameron | 714 | 0 | 0 | 0 | 0 | 0 |
| Collin | 50 | 0 | 0 | 0 | 0 | 18** |
| Colorado | 42 | 0 | 0 | 0 | 0 | 0 |
| Comal | 321 | 15 | 0 | 15 | 0 | 0 |
| Comanche | 108 | 0 | 0 | 0 | 5 | 0 |
| Coryell | 221 | 1 | 0 | 1 | 11 | 0 |
| Dallas | 984 | 59 | 0 | 59 | 50 | 5 |
| Delta | 94 | 0 | 0 | 0 | 0 | 0 |
| Dewitt | 46 | 0 | 0 | 0 | 0 | 0 |
| Dimmit | 1571 | 92 | 0 | 92 | 0 | 0 |
| Duval | 183 | 0 | 0 | 0 | 0 | 0 |
| Ellis | 2974 | 15 | 0 | 15 | 75 | 22 |
| El Paso | 1585 | 38 | 0 | 38 | 0 | 0 |
| Falls | 50 | 0 | 0 | 0 | 0 | 0 |
| Fannin | 53 | 2 | 0 | 2 | 0 | 0 |
| Fayette | 67 | 0 | 0 | 0 | 0 | 0 |
| Fort Bend | 299 | 0 | 0 | 0 | 0 | 0 |
| Frio | 2836 | 26 | 0 | 26 | 0 | 0 |
| Gonzales | 778 | 14 | 0 | 14 | 6 | 1 |
| Grimes | 339 | 0 | 0 | 0 | 0 | 0 |
| Gaudalupe | 469 | 1 | 0 | 1 | 0 | 0 |
| Hays | 197 | 0 | 0 | 0 | 0 | 0 |
| Hidalgo | 1623 | 4 | 0 | 4 | 12 | 0 |
| Hill | 35 | 0 | 0 | 0 | 0 | 10** |
| Houston | 281 | 0 | 0 | 0 | 0 | 0 |
| Hunt | 622 | 3 | 0 | 3 | 0 | 0 |
| Jim Hogg | 379 | 0 | 0 | 0 | 0 | 0 |
| Jim Wells | 334 | 0 | 0 | 0 | 0 | 0 |
| Karnes | 328 | 0 | 0 | 0 | 41 | 3 |
| Kaufman | 70 | 4 | 0 | 4 | 35 | 0 |
| Kimble | 261 | 0 | 0 | 0 | 0 | 0 |
| Kleberg | 168 | 7 | 0 | 7 | 0 | 0 |
| Lamar | 482 | 0 | 0 | 0 | 0 | 0 |
| Lampassas | 223 | 0 | 0 | 0 | 0 | 0 |
| Leon | 161 | 0 | 0 | 0 | 0 | 0 |
| Limestone | 0 | 0 | 0 | 0 | 0 | 3** |
| Live Oak | 829 | 0 | 0 | 0 | 0 | 0 |
| Matagorda | 1004 | 0 | 0 | 0 | 0 | 0 |
| McCulloch | 315 | 0 | 0 | 0 | 2 | 0 |
| McLennan | 21 | 0 | 0 | 0 | 0 | 0 |
| Medina | 217 | 0 | 0 | 0 | 0 | 0 |
| Mills | 702 | 0 | 0 | 0 | 0 | 0 |
| Navarro | 1639 | 5 | 0 | 5 | 41 | 0 |
| Nueces | 1346 | 0 | 0 | 0 | 0 | 0 |
| Red River | 118 | 0 | 0 | 0 | 0 | 0 |
| Runnels | 4 | 0 | 0 | 0 | 0 | 0 |
| San Patricio | 407 | 0 | 0 | 0 | 0 | 0 |
| Travis | 550 | 11 | 0 | 11 | 0 | 0 |
| Uvalde | 1037 | 0 | 0 | 0 | 0 | 0 |
| Ward | 732 | 0 | 0 | 0 | 0 | 0 |
| Webb | 341 | 36 | 0 | 36 | 0 | 0 |
| Wharton | 1174 | 0 | 0 | 0 | 0 | 0 |
| Willacy | 641 | 4 | 0 | 4 | 0 | 0 |
| Williamson | 1050 | 0 | 0 | 0 | 0 | 0 |
| Wilson | 872 | 32 | 0 | 32 | 13 | 3 |
| Zavalla | 298 | 1 | 0 | 1 | 0 | 0 |
| Total | 40557 | 408 | 0 | 408 | 308 | 65 |

**Due to reporting transfers that were ordered in 1923-1924.

## SUMMARY

Inspections were made in sixty-three counties in 1923-1924. American foulbrood was found in twenty-five counties. Of these, five had over twenty-five cases per county, while twelve had less than ten cases per county. Guadalupe and McCulloch counties had only one case each.

Inspections were made in sixty-seven counties in 1924-1925. American foulbrood was found in twenty-four counties. Of these, six had over twenty-five cases per county while twelve had less than ten cases per county. Coryell, Guadalupe, and Zavalla counties had only one case each.

Approximately one per cent of the colonies examined during the biennium ending August 31, 1925, were infected with American foulbroood.

Every case of American foulbrood found in 1924-1925 was destroyed by burning. This is the first time in the history of the inspection work that every case of disease found has been burned.

Inspections were made in forty queen breeding apiaries each of the years herein reported.

In 1924-1925, forty queen breeder's certificates were issued and 11,500 copies of certificates were distributed.

## PUBLICATIONS AVAILABLE

### Order by NUMBER

### BULLETINS

No.
128 Cottonseed Meal as a Human Food (Technical)—1910.
159 Steer Feeding—1913.
162 Composition and Digestibility of the Chloroform Extract of Texas Hays and Fodders (Technical)—1913.
163 Digestion Experimets on men with Cottonseed Meal—1913.
165 Ammonia-Soluble Inorganic Soil Colloids—1914.
166 Digestion Experiments with Texas Feeding Stuffs—1914.
167 Commercial Fertilizers and Their Use—1914.
169 The Total Fatty Acids and Other Ether-Soluble Constituents of Feedstuffs—1914.
170 Texas Feeding Stuffs; Their Composition and Utilization—1914.
171 Losses of Moisture and Plant Food by Percolation—1914.
172 Sudan Grass—1915.
173 The Composition of the Soils of the Texas Panhandle—1915.
174 The effect of Organic Compounds in Pot Experiments—1915.
175 Distribution and Digestibility of the Pentosans of Feeds—1915.
178 The effect of the Additions on Availability of Soil Phosphates—1915.
181 Oxidation of Organic Compounds in the Soil—1915.
182 Steer Feeding—1912.
183 Moisture Relations of Some Texas Soils—1915.
184 Cooperative Fertilizer Experiments with Corn—1908-14.
185 The Production Co-Efficients of Feeds (Technical)—1916.
186 Fattening Lambs—1916.
187 Sprays and Spraying—1916.
188 Tile Drainage—1916.
189 The Composition of Cottonseed Meal and Cottonseed—1916.
190 The Effects of Additions on the Availability of Soil Potash and the Preparation of Sugar Humus—1916.
191 The Composition of Rice and Its By-Products—1916.
192 Soils of Grayson, Lee, McLennan, Titus and Tyler Counties—1916,
195 Japanese Sugar Cane as a Forage Crop—1916.
196 Digestibility of Sugar, Starches, and Pentosans of Roughages—1916.
197 Progress Report, Substation No. 3, Angleton, Texas—1909-14.
200 Progress Report, Substation No. 4, Beaumont, Texas, 1909-14.
201 Peanut Meal and Ground Whole Pressed Peanuts for Hogs—1916.
203 The Productive Values of Some Texas Feeding Stuffs—1916.
204 The Recurving of Milo and some Factors Influencing It. (Technical)—1917.
207 Poultry Houses and Poultry Equipment for Texas—1917.
208 The Fig in Texas—1917.
209 Progress Report, Substation No. 2, Troup, Texas, 1909-14
210 Barns for Work Animals—1917.
211 Field Experiments with Crown Gall—1913-17.
212 The Availability of Phosphoric Acid in Rock Phosphate—1917.
213 The Composition of the Soils of South Central Texas—1917.
214 Progress Report, Substation No. 1, Beeville, Texas—1910-14.
215 Progress Report, Substation No. 5, Temple, Texas—1910-14.
218 Progress Report, Substation No. 7, Spur, Texas—1909-14.
219 Progress Report, Substation No. 8, Lubbock, Texas—1910-14.
221 Progress Report Substation No. 9, Pecos, Texas—1910-14.
222 The Composition of Peanuts and Peanut By-Products—1917.
224 The Influence of Peanuts and Rice Bran on the Quality of Pork—1918.
226 Cooperative Sŏft Pork Investigations—1918.
227 Studies of the Harlequin Bug—1918.
228 The Influence of Peanut Meal on the Quality of Pork—1918.
229 Experiments at Substation No. 3, Angleton, Texas—1909-16.
231 The Beemoth or Waxworm—1918.
232 Mineral Requirements of Sheep—1918.
236 Grain Sorghum Improvement—1918.
240 The Utilization of Yucca for the Maintenance of Cattle—1918.
243 The Need of Texas Soils for Lime—1919.
244 Composition of the Soils of Archer, Franklin and Harrison Counties—1919.
245 Feeding Values of Certain Feeding Stuffs—1919.
247 The Chemical Composition of the Cotton Plant—1919.
255 Beekeeping for Beginners.
258 Report of Experiments at Substation No. 4, Beaumont, Texas—1915-18.
259 Nitrification in Texas Soils (Technical)—1920.
262 The Searing Iron vs. the Knife for Docking or Detailing Lambs—1920.
263 Rations for Fattening Steers—1920.
269 Grain Sorghum vs. Corn for Fattening Lambs—1920.
270 A Study of the Black and Yellow Molds of Ear Corn—1920.
277 Sweet Potato Fertilizer Experiments at Substation No. 2—1921.
279 Type and Variability in Kafir (Technical)—1921.
282 Composition and Feeding Value of Wheat By-Products—1921.
285 Beekeeping for Beginners.
292 The Blueweed and Its Eradication.

295 Correlation between External Body Characters and Annual Egg Production in White Leghorn Fowls.
296 Grain Sorghum vs. Corn for Fattening Baby Beeves—1922.
305 Swine Feeding Experiments—1923.
307 Texas Root Rot of Cotton and Methods of its Control—1923.
308 The Sweet Potato Weevil—1923.
309 I. Fattening Steers on Cottonseed Hulls With and Without Corn.—II. The Influence of Age on Fattening Steers—1923.
310 The Interpretation of Correlation Data—1923.
311 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by range Sheep—1923.
312 Commercial Fertilizers in 1922-23.
325 Effect of Cropping upon the Active Potash of the Soil.
326 Breeding Experiments with Blackberries and Raspberries.
313 Rice Bran and Rice Polish for Growing and Fattening Pigs—1923.
314 Commercial Feeding Stuffs, Sept, 1, 1922 to Aug. 31, 1923.
315 Digestion Experiments with Oat By-Products and other Feeds, Report No. 7—1924.
316 The Soils of Brazos, Camp, Ellis and Washington Counties—1924.
317 Comparative Influences of Various Protein Feeds on Laying Hens—1914.
318 The Relation between Rents and Agricultural Land Values in Theory and in Practice—1924.
319 Field and Laboratory Notes on a fatal Disease of Cattle Occurring on the Costal Plains of Texas (Loin Disease)—1914.
320 The Influence of Individuality, Age and Season upon the Weights of Fleeces Produced by Angora Goats under Range Conditions—1924.
321 Cotton Variety Experiments at the Main Station—1912 to 1922.
322 Commercial Fertilizers in 1923 and 1924.
323 The Price of Feed Utilities.
325 Effect of Cropping Upon the Active Potash of the Soil.
326 Breeding Experiments with Blackberries and Raspberries.
327 An Agricultural Economic Survey of Rockwall County Texas.
329 Energy Production Coefficients of American Feeding Stuffs.
330 Farm Mortgage Financing in Texas.
332 Biometrical Studies of Lint and Seed Characters in Cotton.
333 Heritable Chlorophyll Deficiencies in Seedling Cotton.
335 Commercial Fertilizers in 1924-25.

## CIRCULARS

1 Strawberries Under Irrigation in South Texas—1914.
7 Insect Enemies of Sudan Grass—1915.
10 Housing Farm Implements—1015.
22 The Malvaceous Plants of Texas—1920.
26 Cost of Production; Its Relation to Price—1920.
30 The Practicability of the Milking Machine—1923.
31 Standard Fertilizers and their Use (Reprint)—1923.
32 Cotton Boll Weevil Control in Texas—1924.
33 Texas Agricultural Experiment Station System—1924.
34 The Lower Rio Grande Valley of Texas.
35 Suggestions on Queen Rearing.
36 Foulbrood Control and Diseases of Bees—Foulbrood Law and Revised Regulations.

## ANNUAL REPORTS

25th for 1912; 26th for 1913; 27th for 1914; 28th for 1915; 29th for 1916; 32nd for 1919; 35th for 1922, and 36th for 1923.

Address all communications to

B. YOUNGBLOOD, Director,
College Station, Texas.

Agricultural Experiment Station,
Agricultural and Mechanical College of Texas,

251-703-15m.

Circular No. 4. August 10, 1903.

ENTOMOLOGICAL DEPARTMENT,

TEXAS AGRICULTURAL EXPERIMENT STATIONS.

W. D. GIBBS, DEAN AND DIRECTOR.

Press Notes. Vol. V, No. 1.

FREE.

# HOW TO COMBAT THE MEXICAN COTTON BOLL WEEVIL IN SUMMER AND FALL.

By E. Dwight Sanderson, State Entomologist.

The life history and habits of the boll weevil have been discussed in Circular No. 1 of this office, which may be had on application.

The known methods of satisfactorily controlling damage by the boll weevil may be classed under two general heads; viz.: (1) *Growing an early maturing crop,* and (2) *Destroying the weevils.*

## GROWING EARLY MATURING COTTON.

The first step is to plant early maturing varieties or northern grown seed as early as possible, in wide rows, running them east and west. This has been discussed in Circular 1. Next hoe the cotton to a stand as soon as possible, leaving good distances in the rows; never less than 18 inches, and in bottom lands, two and a half to three feet, or in checks.

The growth of early maturing cotton and hastening the ripening of the crop is advocated for two reasons. (1) It has been found that where injury by the weevil is serious the main part of the crop is that of which the bolls are well set before the middle of July, or in other words before the second brood of weevils appears in force, as this second brood is sufficiently numerous to destroy most of the squares and young bolls. (2) To check the increase of the weevil and to destroy as many as possible before they go into hibernating quarters for the winter (as described below) it is desirable to destroy the stalks in the fall before the first frost, whether there be prospects of a top crop or not. The crop should be grown to ripen early so that the planter will not need to depend on the late pickings to make a profitable crop, but can secure a fair crop by early October.

### SELECTION OF COTTON SEED.

In securing an early maturing cotton much might be done by a simple intelligent selection of the seed during the previous season. Texas growers may well give considerable attention to the building up of improved varieties, maturing earlier, with larger bolls, and better staple. The originator of such a variety may well be called a true patriot. Few planters give any consideration to the selection of the seed. Far too many take their seed from a public gin late in the season, thus securing the very poorest seed as far as the production of an early crop is concerned.

Plants are subject to the same general laws regarding the transmission of characteristics from parent to progeny as are animals. The cattle breeder improves his stock by intelligent selection and crossing. Plants may be improved by the same methods and none are more susceptible to improvement than is cotton. Though many improved varieties have been secured by cross fertilization or hybridization, the great majority have been secured by simple selection of individuals and the continued selection of the seed of their progeny toward a desired standard. Most of the improved varieties of cotton have thus been secured. It is probably because many planters have an exaggerated idea of the method of selection and suppose that all improvement is due to crossing, etc.,

that more do not attempt to improve their seed. For a most excellent description of the methods of selecting cotton seed consult an article in the Yearbook of the United States Department of Agriculture for 1902, The Improvement of Cotton by Seed Selection, by Dr. Herbert J. Webber, pages 365 to 386. Every intelligent cotton planter should carefully read this article. We quote from it the following as being most applicable to the great majority of Texas planters:

"*A Short Method of Seed Selection.*—Select careful pickers that remain on the plantation from year to year and train them to recognize the best plants, that is, those most productive, earliest in ripening, and having the largest, best formed, and most numerous bolls. Each year *before* the second picking have these select pickers go over the field and pick the cotton from the best plants only. These pickers should be paid by the day and not for the amount picked. Preserve such seed cotton separately, gin it separately, and use the seed to plant the general crop the next year. If sufficient seed is not secured at the second picking, the same pickers can be sent over the field again before the next picking. In general, it is desirable *not* to use the seed of the first or last picking. * * *"

In selecting for earliness, it would doubtless be well to go over the field before the first picking and mark the plants with the most bolls, and then pick the selected seed from these plants before the second general picking. In selecting for earliness, other desired qualities should not be overlooked. Were such a simple method of selection generally adopted, we believe that a few years would see an immense improvement not only in the earliness of the crop and consequent lessened injury by the boll weevil, but also in its general quality and amount.

### CULTIVATION.

The thorough, frequent cultivation of cotton until late in the season has been found to greatly increase the yield. Cultivate frequently, keeping the field entirely free from weeds and keeping a thin mulch of well pulverized soil on the surface. Deep cultivation is unnecessary and merely allows the greater evaporation of soil moisture. In cultivating many planters advocate attaching a flexible stick to the plow or cultivator which will brush the cotton and thus knock off any of the punctured squares, which will dry up on the hot soil and thus largely prevent the development of the weevil. Continue cultivation until the cotton is ready to pick. Planters who have pursued this course are practically unanimous in stating that a much larger crop can thus be secured in spite of the weevil than where the crop is only cultivated until early in July.

## II. DESTROYING THE WEEVILS.

### IN EARLY SUMMER.

During May and early June the weevils may be picked from rows of cotton planted extra early as trap rows, and many thus destroyed with profit. The fallen squares which have been punctured by the weevils should also be picked up and destroyed wherever possible and the second brood of the weevil thus be prevented to a large extent. Usually the squares should be picked up from the middle of May until the latter part of June; this year the period of dropping from effect of the first brood extended until the middle of July. Whether it will be profitable to pick up the squares or not will depend entirely upon the size of the plantation, the labor securable, and capital available. It has been most generally practiced by small farmers, where the women and children have picked up the squares, and has been found to materially lessen injury by the weevil.

### IN FALL.

More weevils can be economically destroyed in the fall than at any other season of the year. This may be accomplished by (1) *grazing the cotton with cattle*, or (2) *cutting or pulling and burning the stalks*. Either method involves the destruction of the cotton before frost. Wherever these methods have been used they have been found entirely profitable and practicable. The main objection offered is that the cotton can not be picked by that time and that the "top crop" must be lost. When the weevil becomes abundant in a locality neither of these objections have any weight, for the simple reason that after about October 1st the weevils are so abundant that they destroy all the squares and bolls before they can mature, and it is simply a question of making a crop that

(SUPPLEMENT TO PRESS NOTES, VOL. V, NO. 1.)

TEXAS AGRICULTURAL EXPERIMENT STATIONS.

# ☞IMPORTANT—READ CAREFULLY.☜

## REPORTS UPON COTTON CROPS OF 1903.

We earnestly desire to secure reports from as many planters as possible concerning their cotton crops in 1903, and their past experience with the Boll Weevil. By securing reports from a large number of planters as to varieties used, time of planting, method of cultivation, methods used against weevil and yield at each picking, we will be in a position to state what has been actually accomplished by practical farmers in fighting the Boll Weevil. The value of such evidence must be appreciated by all interested in cotton production. Let us have your co-operation in this matter; if each to whom this circular is sent will reply we will be able to publish the general results of work all over the weevil infested district which will be of the greatest value.

We want only facts. If you cannot answer a question certainly, leave it blank. We do not want opinions, but what you have actually experienced in combating the Boll Weevil.

We send out these blanks at this date so that they can be filled out during the season. Read over the questions carefully and write down the answers during the season as soon as possible. Do not return the blank to us until the crop has been picked. All blanks should be returned by January 1, 1904.

Use a separate blank for each one of fields of different variety, planted on different dates, cultivated differently, on decidedly different kinds of land, belonging to different renters, etc. Additional blanks will be furnished with return postage, upon request.

Do not fail to return blank because you cannot answer all questions.

RETURN TO

E. DWIGHT SANDERSON, State Entomologist,

COLLEGE STATION, TEXAS.

NAME.....

Post Office.....County.....

1. Character of Land. Upland or bottom?.....

   Light or heavy?.....

2. Number of acres in the field?.....Are woods near it?.....

3. Crop on field the previous year (1902)?.....

4. If field was in cotton in 1902 was it grazed off or stalks cut and burned, and if so, when?.....

5. Variety of cotton planted in 1903?.....

6. Date of planting?.....

7. Width between rows?..... Distance in rows?.....

8. Are rows east and west or north and south?.....

9. In what year did weevils first appear on your farm?.....

10. In what year did weevils first appear in this field?.....

11. Number of times cotton was chopped or hoed?.....

12. Date of last chopping or hoeing?.....

13. Number of times cotton was cultivated?.....

14. Date of last cultivation?.....

15. Was cultivation deep or shallow?.....

    Were squares plowed under?.....

16. What kind of sweep or cultivator was used?.....

17. Were any punctured squares or weevils picked up by the hand?

    .....

18. If so, how often, and at what cost per acre?.....

    .....

19. Did picking of squares or weevils prove profitable?.....

.....

20. Were trap rows of early cotton used and weevils picked from them?.....

21. Were any machines for picking up punctured squares or weevils tried, and if so with what results?.....

.....

22. Did you spray with poisons?.....If so, what poison?.....

23. What formula was used in mixing poison?.....

.....

24. How applied?.....Machine used?.....

25. Effectiveness of machine?.....

26. How many applications of poisons, and dates?.....

.....

27. Effect of spraying? (If you did not spray this year, but have previously, give answers to questions 22 to 27 for former years as far as possible.).....

.....

.....

28. Blooming. Date of first blooms of cotton?.....

29. Number of bolls set on Aug. 15, 1903?.....

30. Number of bolls set September 1, 1903?.....

31. Average percentage of bolls not punctured Sept. 1, 1903?.....

32. Average percentage of bolls not punctured Oct. 1, 1903?.....

33. Average percentage of squares not punctured September 1, 1903?.....

34. Average percentage of squares not punctured October 1, 1903?

.....

35. Yield of seed cotton first picking, per acre?.....

Date?.. .....

36. Yield of seed cotton per acre second picking?. .....

Date?.....

37. Yield of seed cotton per acre third picking?.....

Date?.....

38. Total amount of injury to crop by Boll Weevil?.....

39. Total amount of injury to crop by Boll Worm, if any?.....

40. What other insects did any considerable injury to the crop?.....

.....

How much? .....

When? .....

41. Was above cotton grazed in fall of 1903?.....If so, at what date was grazing commenced?.....

At what date stopped?.....

How many cattle per acre?.....

42. Were stalks of above cotton cut or pulled and burned in the fall of 1903?..... .....If so give date of cutting or pulling and date of burning?..... . .....

43. Were weevils found in or under piles of stalks?.....

44. Give manner of burning and cost per acre?.....

.....

.....

45. Date of first frost, fall 1903?.....

(NOTE.—Parties who are willing to co-operate with us in securing data on methods of fighting the Boll Weevil, are requested to observe during 1904 whether there are as many weevils and as much injury in fields grazed or burned in the fall of 1903 as in those not so treated, and blanks upon which to report such observations will be furnished those who report having grazed or burnt stalks this fall.)

Please send us the names and addresses of any parties who have not received this circular, who have had practical experience in fighting the Boll Weevil, who have made careful observations upon the results of their work, or who would be willing to fill out and return the above blank as far as possible.

can be picked by the middle of September or making none at all. But where injury by the weevil has not become so severe the above objections are largely fallacious. Both the statistics for many years and the experience of the oldest cotton growers go to show that it is but once in a number of years, probably not more than once in six or seven years, that a top crop is of any considerable value. What poor policy then to sacrifice the opportunity of destroying a large number of weevils and preventing their increase for the sake of a possible part of a crop once in six or seven years. The boll weevil must be recognized as a permanent factor in cotton growing and if it is to be fought successfully the possibility of securing a top crop or of growing late cotton must be given up and the practice of destroying the stalks by grazing or burning adopted by all, year after year, whether there be the possibility of a "top crop" or not.

The destruction of the stalks is advocated for two reasons. (1) *Large numbers of the weevils are destroyed.* (2) *The increase in numbers of the weevil during late fall is prevented and thus the number going into hibernation for the winter and which will subsequently appear the next spring is materially decreased.* Each weevil lays from 50 to 150 eggs. Were but 25 of these to develop into weevils, there would be twenty-five times as many weevils on November 1st as on October 1st, and often another brood may develop after the latter date.

### GRAZING.

By turning stock in to graze on the cotton a great majority of the weevils, in all stages, may be destroyed. This should be done soon enough before frost so that the foliage and tips of the stalks will be largely consumed before the first frosts. Otherwise the weevils will then leave the cotton for hibernating quarters. Fields to be successfully grazed should not be allowed to grow up in crab grass, and if containing much grass it should be burned off before turning the cattle in to graze. On some land it will not be found profitable to graze with cattle owing to the fact that the tramping will make it impossible to properly cultivate the following season. Also where Johnson grass is starting, cattle might do more harm than good in spreading the seed. On many plantations there are too few stock to properly graze the cotton closely. This difficulty may often be overcome by cutting or pulling and piling most of the cotton, leaving but a few rows standing. The weevils will leave the piles as soon as the foliage wilts and will congregate on the cotton standing, where they will soon be consumed by the cattle. On lands not injured by the tramping the grazing of the cotton with cattle will be found not only one of the best and most economical methods of fighting the weevil, but it is of considerable service in furnishing forage for the cattle. Judiciously pastured a cotton field will furnish sufficient food for a considerable number of stock for from five to seven weeks or more, according to the number of stock used, size of cotton, season, etc. Abundant experience has shown the profit of such grazing both in the effect on the weevil and as food for cattle. It is but another argument for planters on the lighter soils to keep more stock, as it is on the lighter soils, which most need the manure, that this method can best be used.

### BURNING THE STALKS.

Two methods—both being adapted to meet local conditions—of burning the stalks have been used. In the first, the stalks are cut or pulled and stacked in piles or windrows early in October. It is much preferable to pull the stalks where possible, as many weevils have been found to hibernate in the crevices of the soil at the bases of the stalks, and by pulling the stalks such weevils are thrown out and their winter quarters destroyed. All stalks must be piled before frost. The weevils will take refuge in these piles for winter quarters and as soon as they are sufficiently dried, or even before by covering them with crude oil, they should be burned, thus destroying the weevils. The second method consists in piling or windrowing all but a few rows here and there which are left standing. If no frosts occur many of the weevils will leave the piled stalks and assemble on the standing cotton. When the piles are sufficiently dry to burn, or by the addition of crude oil, they are fired and the rows left standing are quickly cut and thrown on the burning piles, the weevils in all stages on the trap rows thus being also destroyed. The cost of this burning is slight, and the stalks should be cut or pulled in any event, so that it really adds but little cost.

Objection has been raised that the burning of the stalks depletes the land of fertility. The ash of the stalks, containing the mineral constituents, is, however, returned to the soil, and the quantity of organic matter lost is not sufficient in comparison with the benefit resulting to be considered. A proper rotation of crops, and turning under a crop of cow peas now and then will furnish much more organic matter with far greater benefit to the land.

That the burning of the stalks and the consequent destruction of the weevils in the fall is of great practical value in reducing injury the next season has been abundantly proven both by the experience of practical planters and careful experiments. Mr. W. D. Hunter, in charge of boll weevil investigations of United States Department of Agriculture, in his report on Methods of Controlling the Boll Weevil*, gives the results of his experiments in burning the stalks as follows:

"At Victoria early fall destruction of the plants the preceding year was found to bring about a very noticeable decrease in the number of weevils. For instance, as late as October 10, in a field upon which plants of the previous year had been destroyed by September 20, about 33 per cent. of the squares were uninjured, while on fields in similar situations, planted about the same time, but upon which the plants had not been destroyed in the fall, it was impossible to find a case were more than 8 per cent. of the squares were uninjured at that time. It was also shown at Victoria that the weevils caused less damage in cotton planted only moderately early (week ending March 10) on land upon which the plants of the preceding season had been destroyed by burning early in the fall than in fields planted late (week ending April 30) on land that had never been in cotton and which, moreover, were measureably isolated from other cotton fields."

In other words, as late as October 10 of the following year in a field in which the stalks had been burned the previous fall there were 25 per cent., or one-fourth the total number of squares, more uninjured squares per stalk than in a field where nothing had been done. Earlier in the season the difference was undoubtedly even more marked and might easily be sufficient to permit a fair crop to be made on one and an unprofitable crop on the other.

There is but little if any use in burning the stalks after several heavy frosts or in midwinter, as the weevils will have left them by that time. Neither the weevil nor its eggs, larvæ, or pupæ, remain within the stalk or limbs over winter. Several insects which lay eggs in the stalks or hibernate in some stage in them have been frequently mistaken for the weevil and stalks burnt in mid winter on account of them, without, of course, any effect upon the weevil. Often weevils, larvæ, and pupæ, are found in the unmatured bolls left upon the plants, especially in South Texas, but few of these survive the winter.

### PLOWING.

After burning the stalks, or grazing, plow the land deeply and thoroughly in late fall. This will turn under any squares in which weevils may be developing and any weevils that may be under trash or clods, or in the crevices at the bases of the stalks. It will also destroy many of the pupæ of the boll worm, and is one of the most important measures in successfully combating the latter pest. The ground will also be in much better condition for early planting the next spring.

### TO SUMMARIZE BRIEFLY THE PROCEDURE ADVISED.

1. Cultivate as Late as Possible or Until Picking.
2. Select Seed for Next Year's Planting Before Second Picking.
3. Graze or Cut and Burn Cotton Stalks Early in October.
4. Plow Land Deeply and Thoroughly in Late Fall or Early Winter.

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*Methods of Controlling the Boll Weevil, by W. D. Hunter, Farmers' Bulletin No. 163, U. S. Department of Agriculture, to be had by addressing any member of Congress or Secretary of Agriculture, Washington, D. C.

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